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ABSTRACT

This instructional unit contains four classroom lessons dealing with energy for use in grades six and seven. The overall objective is to provide students with a comparative overview of two basic energy concepts: energy is a basic need in all cultures; and energy use affects the way people live. In the lessons, which can easily be integrated into studies of world cultures and physical geography of the world, students compare Accra, Ghana, with the Washington, D.C. area in terms of climate, geographic location, energy dependence, and services that meet their needs. The four lessons developed by teachers are: (1) A Geographical Picture of Two Cities; (2) Tracing the Sources of Electric Power in Ghana and in the Washington, D.C. area; (3) Two Transportation Systems: How Are They Alike? How Are They Different; and (4) How Is Electricity Used In Two Different Cultures? The second lesson can also be taught in science courses. Students construct climagraphs, analyze and interpret fact sheet maps and bar graphs, answer questions about highway and road maps, and examine case studies. A time allotment varying from one to four classes for each of the four lessons is suggested, but will probably vary depending on student interest and ability. Each lesson contains complete teacher and student materials background information for the teacher on the topic under study. (Author/RM)

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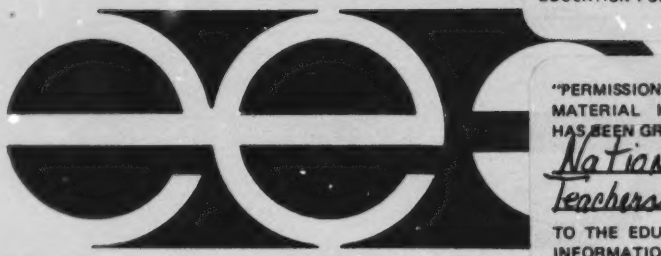

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Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy

BRINGING ENERGY TO THE PEOPLE:

Washington, D.C. and Ghana

Grades 6, 7

February 1978

National Science Teachers Association

SE 011 027

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"Bringing Energy to the People: Washington, D.C. and Ghana" is the product of a writing session held at the University of Maryland during Summer 1977. The following teachers were the main contributors to this unit:

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January 1978
John M. Fowler
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BRINGING ENERGY TO THE PEOPLE:
Washington, D.C. and Ghana

Introduction

The social studies curriculum at the sixth and seventh grade levels consists of studies of world cultures as well as the physical geography of the world. This unit covers both areas of study in a comparative overview of two basic energy concepts, which are: 1) energy is a basic need in all cultures, and 2) energy use affects the way people live.

In this unit students will be able to compare Ghana with the Washington, D.C. area in terms of climate, geographic location, energy dependency, and services that help people meet their needs.

A time allotment for each of the four lessons has been suggested, but will probably vary depending on such factors as the ability of the students, interest, and how the unit is integrated into an existing unit of study on Africa.

Each lesson contains complete teacher and student materials and suggestions for extending the learning beyond the classroom and for independent study.

	Lesson Title	Target Audience
1.	A Geographical Picture of Two Cities	Social Studies
2.	Tracing the Sources of Electric Power in Ghana & in the Washington, D.C. Area	Social Studies and Science
3.	Two Transportation Systems: How Are They Alike? How Are They Different?	Social Studies
4.	How Is Electricity Used in Two Different Cultures?	Social Studies

Lesson 1: A GEOGRAPHICAL PICTURE OF TWO CITIES

Overview

This lesson is intended to develop the students' understanding of the exact geographic locations of two cities and the effects of those locations on each city.

Objectives

The student should be able to:

1. Locate Ghana and Washington, D.C. using longitude and latitude lines.
2. Discuss the climate in two capital cities--Accra, Ghana and Washington, D.C.

Materials

World map or globe.

Background Information (Teacher Use Only)

To show location on a map, map-makers use sets of lines. One set runs north and south, the other set runs east and west.

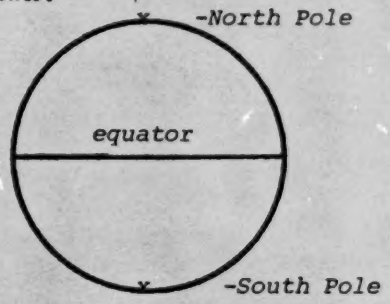
Lines that run east and west are called latitude lines. These lines give the position of a place in reference to the equator. Latitude lines are parallel to the equator and are equidistant from the equator for their entire length around the earth. Latitude lines are numbered from 0° to 90°; the equator is 0° and the North Pole and South Pole are 90°. To avoid confusion, the latitude line at 40° between the equator and the North Pole, for example, is 40° North latitude. In the same way, the 40° line between the equator and the South Pole is 40° South latitude. The latitude of a place usually gives us some indication of the climate. The low latitudes, 0° to 30° are near the equator. These places of low latitudes are sometimes called the tropics. A tropical climate is a hot climate throughout the year because in this area the sun's rays are most direct. The middle latitudes, 30° to 60° north and south of the equator, have very changeable weather and seasonal changes. This area has a temperate climate. The high latitudes, 60° to

90°, have a cold climate. At 66 1/2° N latitude and 66 1/2° S latitude, there is a day in winter when the sun never rises above the horizon. They also have a day in the summer when the sun never goes below the horizon.

Longitude lines run from the North Pole to the South Pole and meet at the poles. The distance between any two longitude lines is greatest at the equator. Longitude lines are numbered in degrees from 0° at Greenwich, England to 180° at the International Date Line in the Pacific Ocean.

Teaching Strategies

Tell the students that they are going to learn how to locate places on a map. Give the students a piece of paper. Tell them to: a) draw a circle and b) draw a line horizontally in the middle of the circle. This line represents the *equator;* it divides the earth into two parts, the northern hemisphere and the southern hemisphere. The northern hemisphere is between the equator and the North Pole and the southern hemisphere is between the equator and the South Pole. Have the students label the parts drawn.



Introducing and Developing the Lesson

Latitude lines run parallel to the equator. They are numbered from 0° to 90°. The lines tell us how far north or south a place is from the equator. Have the students go to a map or globe and find the lines of latitude. Have them determine the latitude of the following places:

Lima, Peru	*(12°S latitude)*
New Orleans	*(30°N latitude)*

Have the students find other places with the same latitudes. *(Indianapolis; Peking, China)*

Have the students go to the map and find longitude lines running from the North Pole to the South Pole. Tell the students that these lines give location for east or west. They, too, are

numbered in degrees like latitude lines. Have the students find 0° longitude. Tell the students that this place is in Greenwich, England, and that the decision to use Greenwich was made many years ago. Show the students the International Date Line at 180° East or West longitude. Using the map or globe, have the students find the longitude of the following places:

New Orleans	*(90°W longitude)*
Hamburg, Germany	*(10°E longitude)*
New Delhi, India	*(77°E longitude)*
Lima, Peru	*(77°W longitude)*

When longitude and latitude are used together, you can find the exact location of a place. Have the students locate the following:

New Orleans	*(30°N latitude; 90°W longitude)*
Lima, Peru	*(12°S latitude; 77°W longitude)*
New Delhi, India	*(28°S latitude; 77°E longitude)*
Hamburg, Germany	*(53°N latitude; 10°E longitude)*

Concluding the Lesson

Tell the students that we are going to study two capital cities, Accra, Ghana (Africa) and Washington, D.C. Have the students locate the two cities. Ask them to look at Map 1 and describe the kind of climate they would expect to find in Washington, D.C. and in Accra, Ghana.

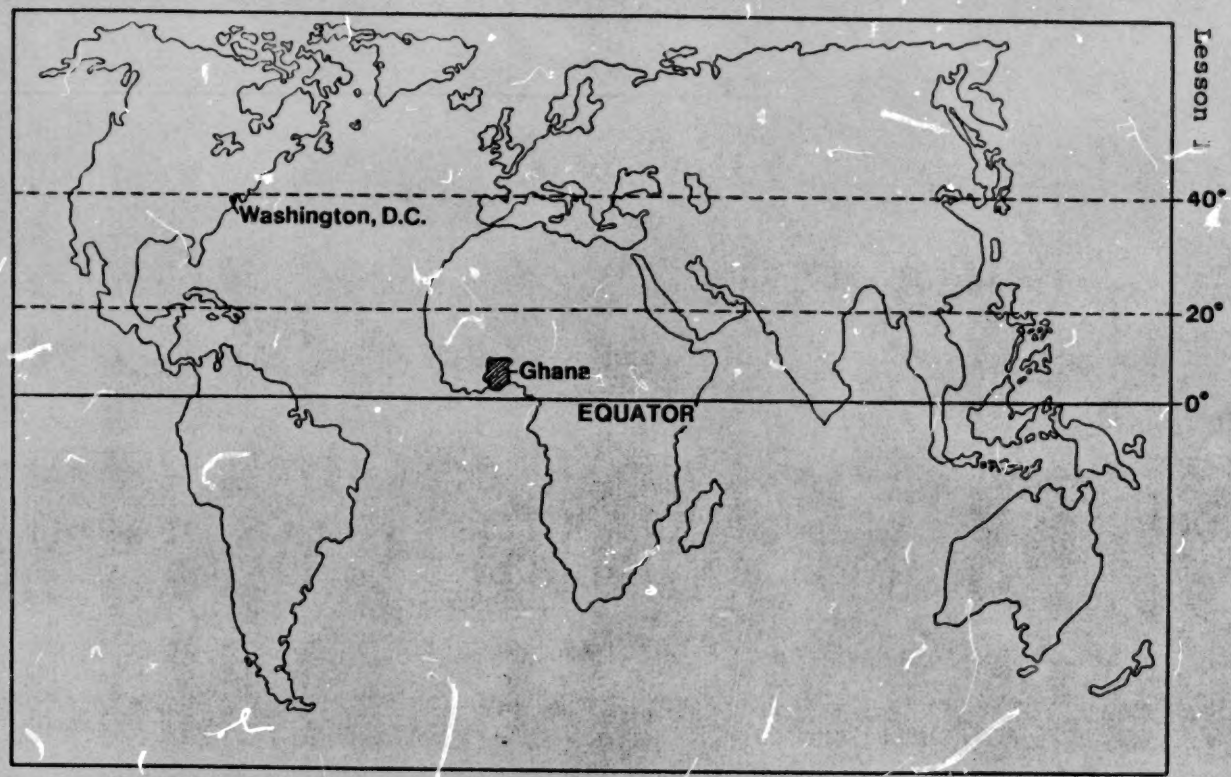
Tell the students that they will construct a *climagraph. (A graph which gives two sets of data: temperature and precipitation.)*

Make a copy of the chart below and give to the students. The climagraph for the capital city, Accra, Ghana, has been done (see Chart 2). Use the data and construct one for Washington, D.C.

Climagraph Washington, D.C.

Months	Temperature	Precipitation (in inches)
January	33° F	2.3
February	38	2.7
March	42	3.0
April	50	3.0
May	55	3.0
June	62	3.2
July	71	3.7
August	77	4.0
September	68	3.5
October	53	3.0
November	42	2.5
December	35	2.0

Map 1



Lesson 1

Latitude and Climate

Low Latitudes 0° to 30°
- Tropical climate -- hot all year round.
- Tropical savanna -- a dry season and wet season.

Middle Latitudes 30° to 60°
- Humid subtropical -- summers warm and humid, winters mild (seasonal changes and very changeable weather).

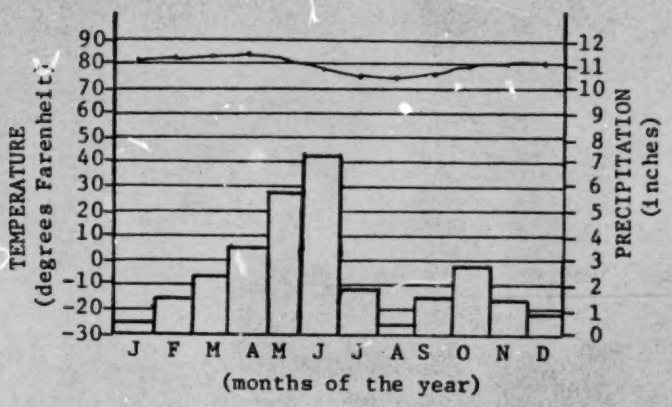
High Latitudes 60° to 90°
- Tundra -- winters are very cold (in the extreme north and south it is cold all year round).

Student Activity 1
(Teacher's Copy)

Climagraph for Accra, Ghana and Washington, D.C.

A sample climagraph for Accra, Ghana (Africa)
_____ ° South Latitude____° East Longitude

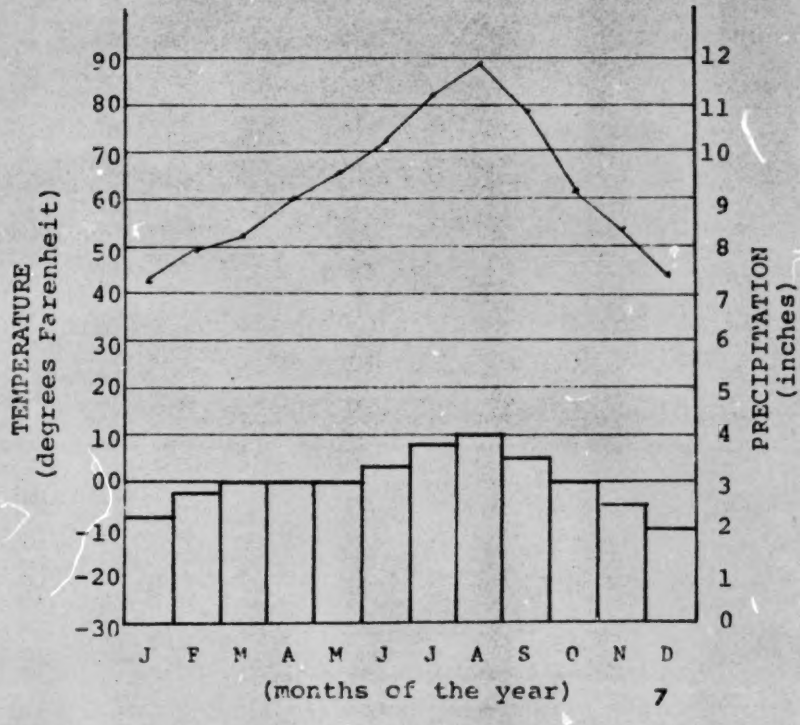
Chart 2



Climagraph for Washington, D.C.
_____ ° North Latitude____° West Longitude

Chart 3

Months	Temperature (°F)	Precipitation (inches)
January	33	2.3
February	38	2.7
March	42	3.0
April	50	3.0
May	55	3.0
June	62	3.2
July	71	3.7
August	77	4.0
September	68	3.5
October	53	3.0
November	42	2.5
December	35	2.0



Lesson 2: THE SOURCES OF ELECTRICITY IN GHANA AND IN THE GREATER WASHINGTON, D.C. AREA

Overview

This lesson will compare the electrical power sources of the nation's capital area, Washington, D.C. and its suburbs, with Ghana in West Africa.

Objectives

The student should be able to:

1. Locate cities, power stations and dams on a map.
2. Use a map key to locate electrical energy sources.
3. Trace a route on a map.
4. Interpret symbols and scale on maps.
5. Collect information from special purpose maps and charts.

Time Allotment

One-two class periods.

Background Information (Teacher Use Only)

The people of Ghana receive all of their electrical power from two sources. The largest source is Akosombo Dam located on the Volta River. The dam was completed in 1965 with aid from the United States. The bulk of its power goes to Accra, the capital city, and Tema, the largest industrial city. The rest of the power goes to other major cities in the southern region of the country. The cities in the northern part of Ghana still rely on diesel-generating plants for electricity.

The Akosombo Dam is located 70 miles from the mouth of the Volta River, on Lake Volta. Lake Volta is the world's largest man-made lake. It came into being when the dam was built; it is 250 miles long and covers 3,275 square miles. The dam was built to supply electricity to the country. The hydro-electric system consists of a rock-filled dam, a power house and a transmission station. The power house contains six turbines that drive six generators with a total generating capacity of 912 megawatts.

The Potomac Electric Power Company provides electrical power to the Washington, D.C. area. (This area includes the nation's capital and many portions of Prince George's County, Montgomery County, in Maryland and Arlington in Virginia.) The company serves about 643 square miles. Six generating stations/power plants supply 4,286 megawatts of power to over 2,000,000 people in the greater Washington area.

Developing the Lesson

Give students the Factsheet/maps of Ghana and the USA (Map 1) and help them draw comparisons between the sources of power in Ghana and in the Greater Washington, D.C. area.

1. What is the capital of Ghana? *(Accra.)* Of the United States? *(Washington, D.C.)*

2. Which capital city has the most people? *(Washington, D.C. -- only a few more.)*

3. What is the main industry in Ghana? *(Growing and exporting cocoa.)*

4. Where do people earn more money each year -- in Accra or in Washington, D.C.? *(Washington, D.C.)*

5. Look at the electrical energy sources in Ghana on the map. Find the Volta River. With your fingers trace the Volta River from its mouth to the Akosombo Dam. Use your ruler and the map scale to measure the distance from the mouth of the Volta River to the Volta Dam. How far is it? *(About 70 miles.)*

   Measure the power line from the dam to Takoradi. How many miles? What would this be in kilometers? *(170 miles or 272 kilometers.)*

6. Point to Lake Volta on the map. A few years ago 80,000 people lived on the land now covered by the water in the dam. These people had to move somewhere else. Where do you think they moved to? *(Allow time for student answers. Many moved to Accra. You may wish to explain that when big projects like dams are planned, governments help people to re-*

locate in other places and often help them find housing and jobs. Should the discussion take this direction, you may want to go into the feelings of people toward relocating in new places and leaving old and familiar ones.)

7. What energy sources are used to produce electricity in Washington, D.C.? (Oil and coal are used in power plants to produce electricity. There are no hydroelectric stations.)

8. Use your finger and point out the six power stations in and around the city of Washington. What kind of fuel does each use? *(Dickerson--coal; Potomac River--coal; Buzzard Point--oil; Benning--oil; Chalk Point--coal and oil; Morgantown--coal and oil.)*

9. In which place do you think people use more electricity--Accra or Washington? *(In Washington, D.C.)*

10. What do you think they use electricity for? *(Let students make as long a list as they can in naming the uses of electricity.)*

10. Where do people depend on electricity? *(Washington, D.C. At this point, you may wish to expand the idea that all places do not use as much electricity as America does, that many countries have always lived without as many appliances and conveniences. Now, however, many countries are beginning to develop sources of electric power to add more comfort to their lives. Ghana is one of these countries. In many ways the people of Ghana live the same way Americans do, but they do not depend on electricity as much.)*

Concluding the Lesson

Remember the times when the electricity went off? What appliances wouldn't run anymore? How did you feel? What things did you substitute for ways to cook? To heat the house? For T.V. and lights to read by?

Where does Washington, D.C. get its power if the generating station/power plants shut down all at once? Where can the people of Accra get power if something happens to the electric power that comes from the Akosombo Dam?

Distribute copies of the Case Study. Have two students take the parts of the girls talking as the rest of the class follows along with the story.

Extending the Lesson

Distribute copies of the Akosombo Dam in Ghana. Have students use their fingers to trace the production of electric power from water power. Help them to trace this by locating important words in a finish-the-sentence activity.

1. Water flows from the dam through a large pipe called a *penstock*.
2. The water then falls on a wheel with curved blades called a *turbine* and makes it spin.
3. The turbine is connected to a *generator* that produces the electricity.
4. The water is returned to the river below the dam through the *tail race*.

Note: The higher the dam, the greater the pressure of the falling water and the more electricity it will produce. If the water level gets too high on Lake Volta, water can run to the river below through the two spillways located on either side of the dam.

Compare the Ghanaian system of producing electricity to a system in our country. Washington, D.C., the nation's capital, is supplied with electricity by six power plants of the Potomac Electric Power Company.

Give each student a copy of Electrical Power Sources in the Greater Washington, D.C. Area (Map 2). Have the students study the picture.

In the Washington, D.C. area electrical energy is produced by thermal energy. This means oil, or coal are used to produce electricity. Look at the picture.

1. The *fuel* used in the Washington, D.C. area to produce electricity is *coal, oil*
2. It goes through special processing and then is sent into the furnace where it is burned to produce heat which is used to boil water & create steam.
3. The steam turns the turbine which sends energy to the electrical generator.
4. Electricity is sent through transformers for transmission and distribution.

Energy Source Comparisons

Look at the diagram of the dam in Ghana and the power station in Washington. D.C. What do you see that is familiar? *(Transformer, generator, turbine, transmission lines.)*

What is different? *(Student answers will vary. One possible answer is: the fuel in the dam is water power so the dam is a hydro-electric power source. The power station in Washington, D.C. uses coal or oil, so it is a thermal electric power source.)*

Look at the picture of a Nuclear Generating Station. What do you see that is similar to the fossil fuel burning plant? *(Steam, turbine, condenser, generator, transmission lines.)*

What is different? *(The fuel source is the major difference.)*

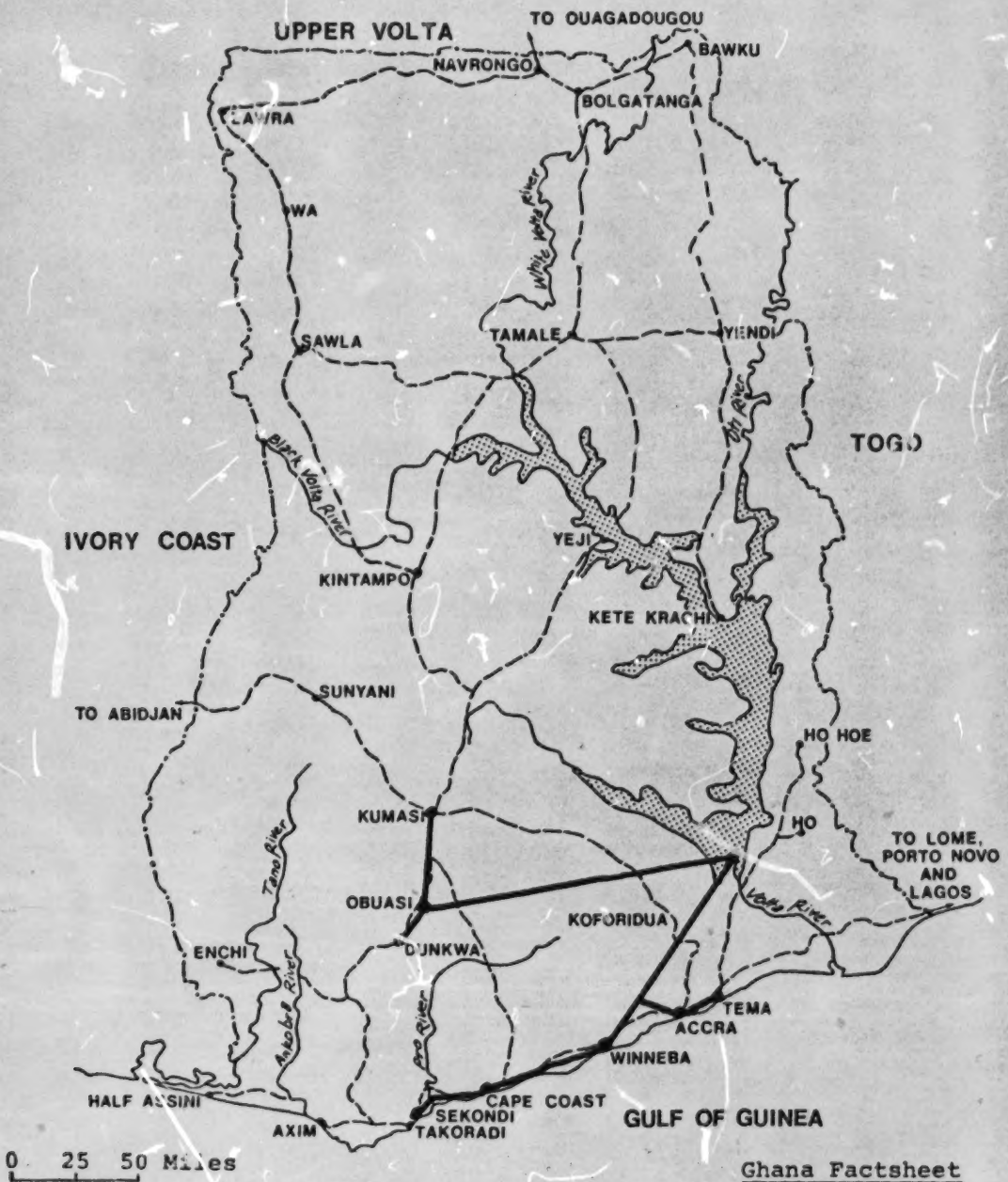
Sources

1. Energy-Environment Source Book, John M. Fowler.
2. Ghana '76: An Official Handbook, Government Publication.
3. Ghana and Beyond - Junior Secondary Geographics for West Africa, H.P. Turner.
4. PEPCO Annual Report, 1976.

Map 1

Lesson 2

Electrical Power Sources in Ghana

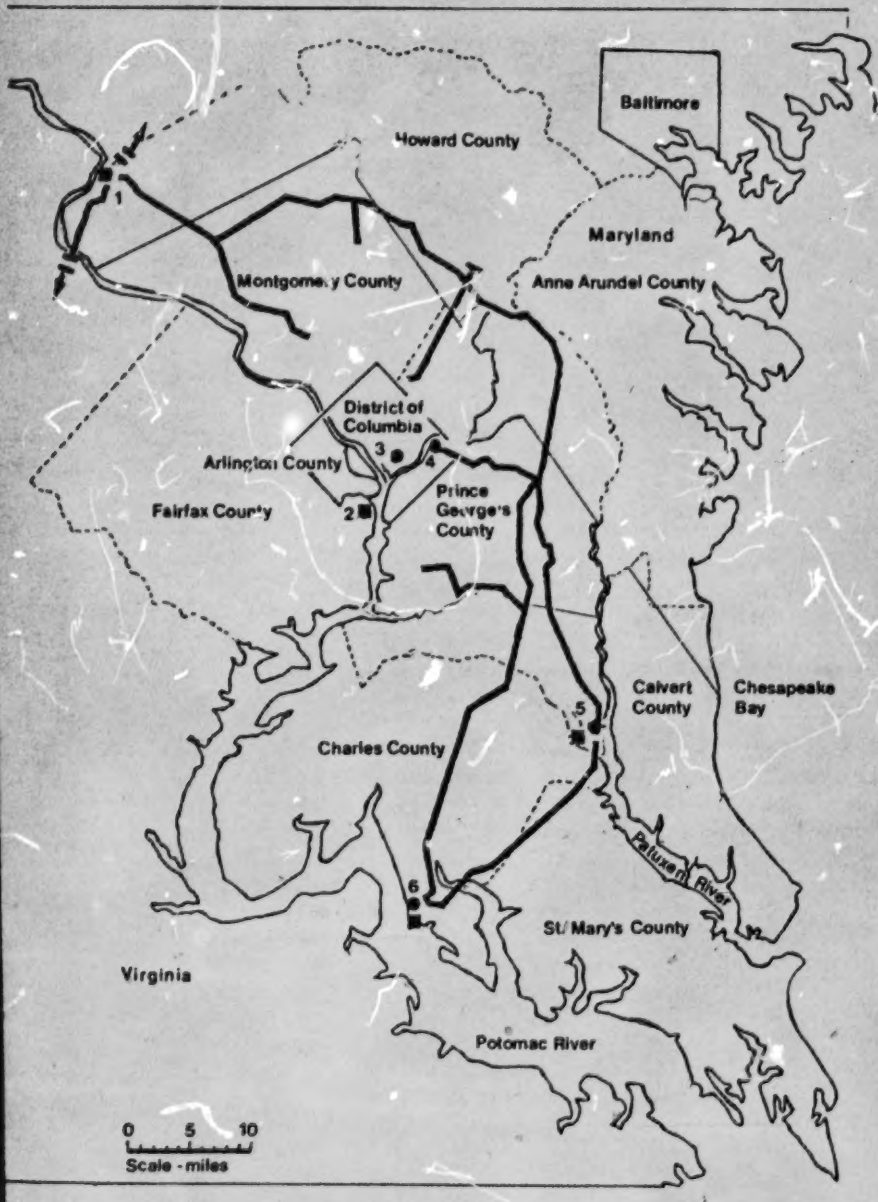


Ghana Factsheet

Capital City	Accra
Population of Accra	633,880
Chief Industry	Growing and exporting cocoa
Average Income per family per year	$560

Map 2

Electrical Power Sources in the Greater Washington, D.C. Area



PEPCO Service Area

Transmission Line (230 kv)

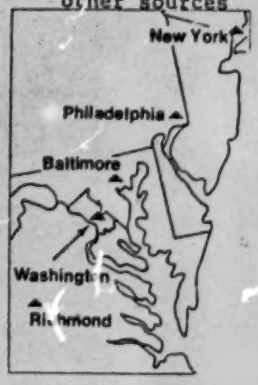
PEPCO Generating Plants by Type

■ Coal Fueled

● Oil Fueled

	Net Capacility at December 31, 1976
1. Dickerson	548 MW
2. Potomac River	458 MW
3. Buzzard Point	272 MW
4. Benning	284 MW
5. Chalk Point	1262 MW
6. Morgantown	1112 MW

Power from other sources



U.S.A.

Washington, D.C. Factsheet

Capital City	Washington, D.C.
Population of Washington, D.C.	757,000
Chief Industry	Government, shops, many services
Average Income per family each year	$19,000

Student Activity 3

Case Study

What would happen if the lights went out? Lisa, a seventh grader living in the Washington, D.C. area and Caroline, a seventh grader living in Accra, Ghana, are on a Washington, D.C. playground discussing their countries. The time is the summer of 1977. (Note: Caroline speaks a more formal English because she has been going to schools that have a British influence. The children in Ghana do not use as much slang as we do. [Most Ghanaians have first names just like those we have.])

Caroline: When I came to the United States this summer something strange happened. I was staying with my Aunt in New York City and it had been hot all day. That night there was a terrible storm. I awoke and it was dark everywhere. My Aunt told me there was no electricity in all of New York City. The air conditioning was off and the apartment was very hot. It was like that for 25 hours. People did not go to work and some people got angry. Does this happen often?

Lisa: No. That was unusual. I think it was an accident.

Caroline: Did it ever happen in Washington?

Lisa: No, I don't think so. PEPCO says it never happened here - yet.

Caroline: What is PEPCO?

Lisa: PEPCO is the Potomac Electric Power Company. They make the electricity here.

Caroline: Oh, that's like our Electric Corporation in Accra the capital city. Accra is my hometown and it's the capital of Ghana. Why wouldn't the power fail here?

Lisa: I guess because we get power from six power plants/generating stations around the Washington area, and if one isn't working the others could still work.

Caroline: Suppose they all went out?

Lisa: Well, we belong to a network of energy producers called the Pennsylvania, New Jersey, Maryland Interconnection. When it's very hot or very cold and we need more power than we make here, we can get power from this interconnection. In an emergency that's where the power would come from.

Caroline: But if it would?

Lisa: Well, in the summer the air conditioning wouldn't work. That would be awful! If you stay here all summer you'll find Washington really gets hot. Food might spoil because the refrigerator would be off too! And the subway wouldn't work, so people would have a hard time getting to work. And there wouldn't be any traffic lights so traffic would get tangled up. There

wouldn't even be T.V., and I'd sure miss that. But it would be worse at night. Without street lights you couldn't even be outside at night. It would be one grand mess!

Caroline: Would you go to school?

Lisa: Yes, we'd go to school -- no matter what!

Caroline: Sounds pretty bad. You really depend on electricity.

Lisa: Why, we couldn't even cook because a lot of homes use electric appliances. And what would really be bad is we couldn't even go to the shopping centers or to the movies! That's scary!

Caroline: In my country, I don't think we need electricity as much as you do.

Lisa: You mean that if the electricity went off, you would do the same things you normally do?

Caroline: I think so. Our temperature stays pretty much the same, so we don't need electricity to heat our homes. It does not get below 60°.

Lisa: But it's hot in Ghana. How do you keep cool?

Caroline: I'm used to it and it doesn't bother me. We don't use air conditioners. We fan ourselves sometimes.

Lisa: How do you cook food, and keep your food cold?

Caroline: My mother uses the charcoal pot and cooks outside. Grandma does, too. Most people in Ghana cook this way. It's like a patio cookout - only Ghanaians cook this way most of the time. We have a refrigerator, but most homes

don't have them. We buy fresh meats and vegetables every day from the market.

Lisa: What about reading and T.V.?

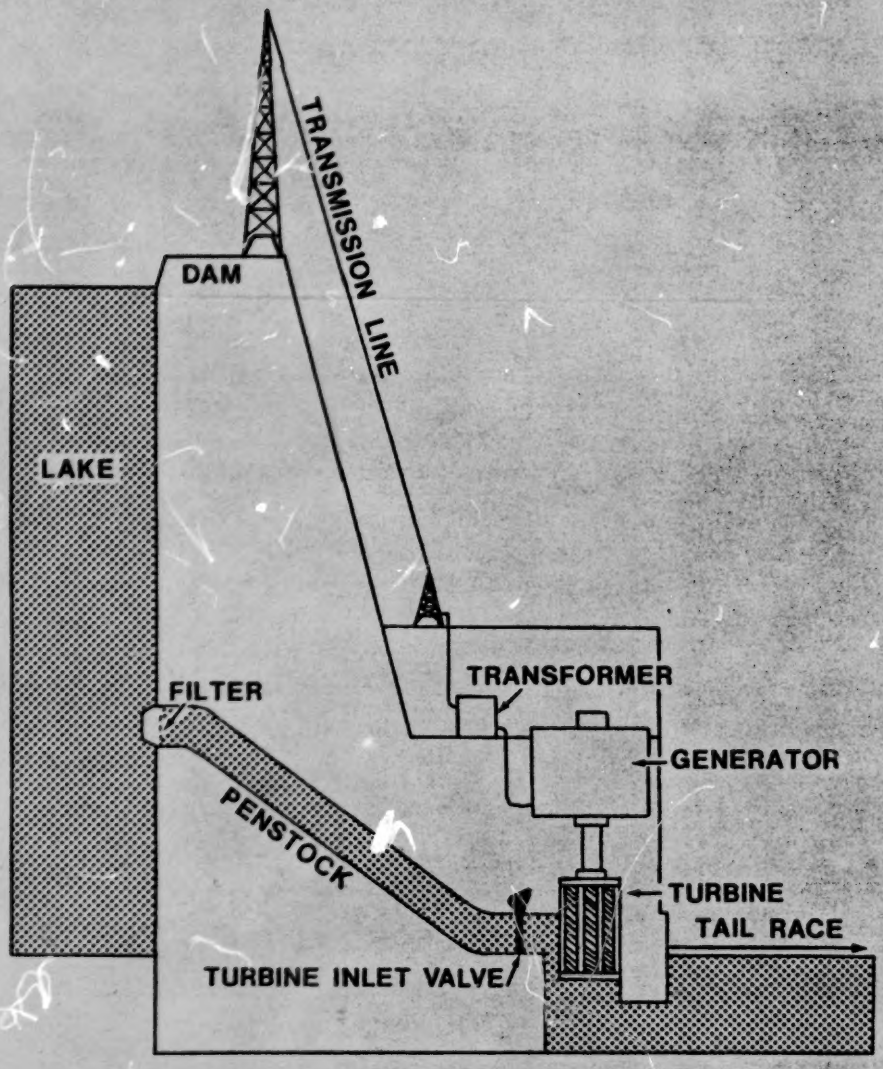
Caroline: Well, at night if the lights were out, I would use a candle or an oil lamp. Most Ghanaians don't have a T.V. set so we wouldn't miss it.

Lisa: So a power blackout wouldn't bother you?

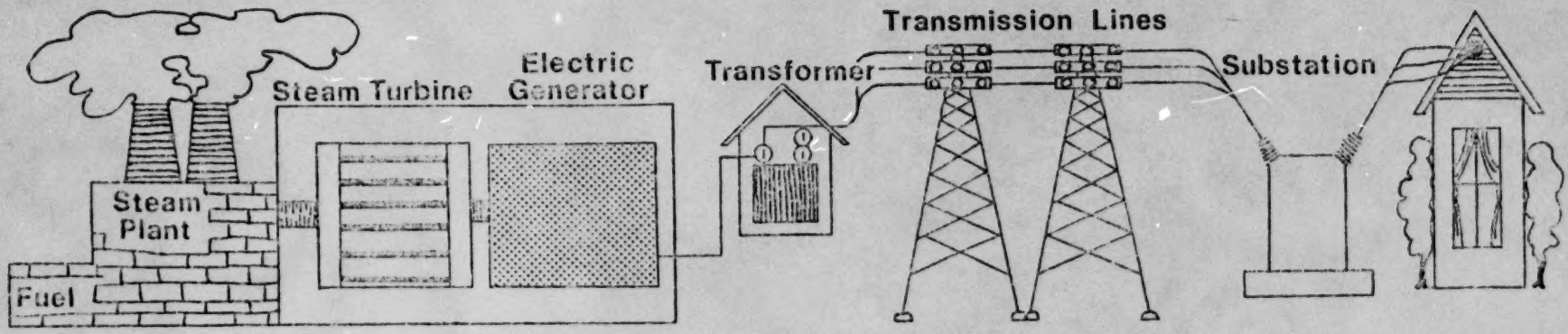
Caroline: Oh, yes! But it wouldn't be as bad as it is here. People could still go to work because we would use electricity from diesel power plants.

Lisa: Could you get power from other countries, like the Ivory Coast or Togo?

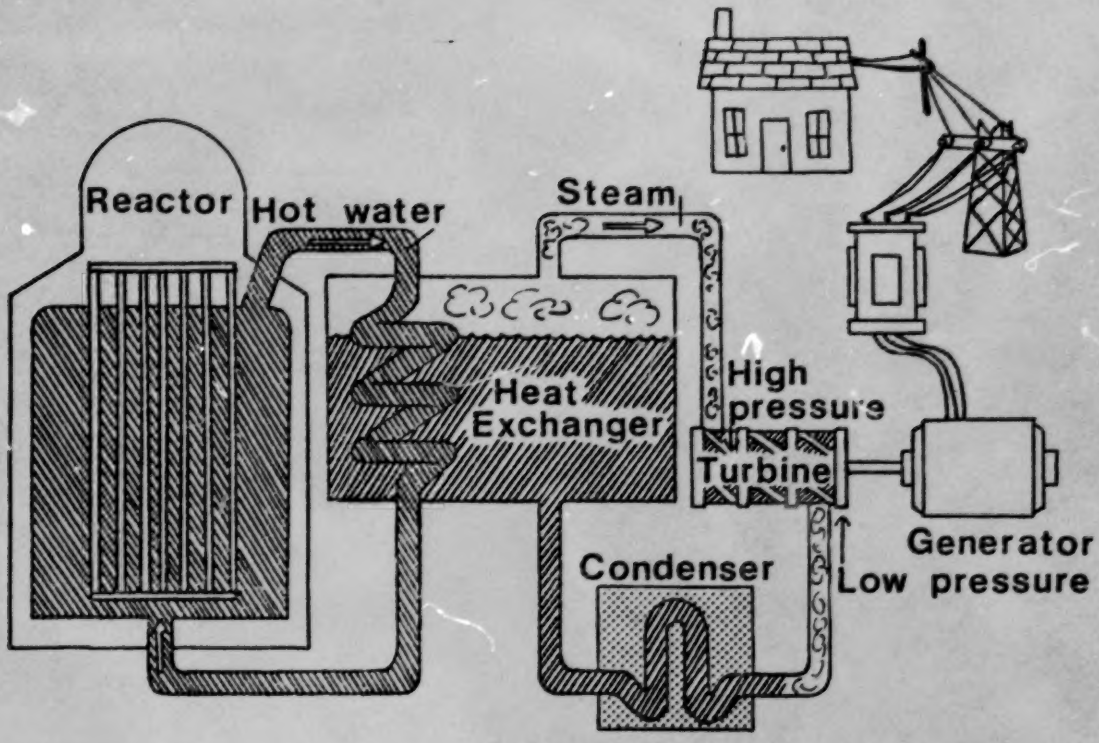
Caroline: No, we sell a lot of energy to Togo and we don't have an interconnection as you called it. All of our electricity comes from Akosombo Dam or diesel generating plants or from candles, oil lamps and charcoal stoves.



Akosombo Dam in Ghana



Power Station in Washington, D.C.



Nuclear Generating Station

Lesson 3: TRANSPORTATION SYSTEMS ARE ALIKE AND DIFFERENT

Overview

Transportation systems provided by two cities and national governments are described in this lesson. The relationship between energy use and various methods of transporting people and goods is pointed out, especially as these relate to existing facilities.

Objectives

The student should be able to:

1. Measure and compare distances.
2. Locate places and trace routes on a series of maps.
3. List the advantages and disadvantages of high energy use in transportation systems.

Time Allotment

One-two class periods.

Teaching Strategies

Open the lesson by pointing to the word *Transportation* on the chalkboard and get the definition from the class. Ask: Why is transportation important? Place the question on the board and encourage students to speculate on what their city would be like without this service.

Developing the Lesson

Part 1 Railroads in the United States

Direct the attention of the class to the map showing U.S. Railroads. Point out that this map does not show all of the railroad lines. A map like that would be too difficult to read. With desk atlases or a wall map, ask students to locate and print the names of the cities that have several railroad lines crossing them. Dots on the map will help them find these cities.

When students have finished this part, ask: What other transportation forms do you think these cities might have? *(Airlines, highway systems, subways, ships, river barges, etc.)*

Ask: According to the map, can people and things get to Washington, D.C. by rail? Ask the students to trace the rail routes into the capital by using their finger or tracing the lines with a pencil.

Using Washington, D.C. as a starting point, have students trace a southern route to the west coast. Have them trace a northern route taking imaginary goods from Washington to a place in California. Locate a route that will take them from coast to coast through the central parts of the nation. Encourage students to speculate on the advantages of coast to coast rail service. How do railroads link the continent from north to south? Discuss how the railroads help the United States. How do they help cities?

Railroads in Ghana

Distribute the map showing railroads in Ghana. Have students locate the places where railroad lines seem to be concentrated. Have them trace various routes with their fingers. Point out that Ghana's railroad system is located almost entirely in the south. You might mention that these tracks are of special importance in getting cocoa to marketplaces and shipping ports. Track length is nearly 592 miles. Main lines run from Accra to Kumasi. This is called the Eastern Line. The Western Line connects the cities of Takoradi and Kumasi. The Central Line runs westward to join the Western Line at Huni Valley. Shorter lines of track connect resource sites to distribution centers and are not shown on the map. Point out that the numbers on the map show the distances between towns. Have students compute distances by adding several together to get a total. Ask a series of questions such as: Suppose I want to take cocoa to _____ from _____. How far would the train travel?

Another activity could involve making up time schedules for the trains. Have an interested group of students make up a distance and time chart and tell their ideas to the class.

Ask students what goods they think are transported to and from the northern parts of Ghana. A geography text should help them find these products. Contrast the railroads in Ghana with the network of rail lines in the United States.

Have students use the string measure to find distances and answer the three questions on the map showing the railroads in Ghana.

Answers to Questions on Railroads in Ghana

1. *Yes. Train would have to go from Kumasi to Konongo then travel south to Koforidua and Kotoku. From there the train would travel southeast to Tema. It would be just a short hop south from Tema to Accra. Going the other way round would require much more time.*

2. *At least 200 miles.*

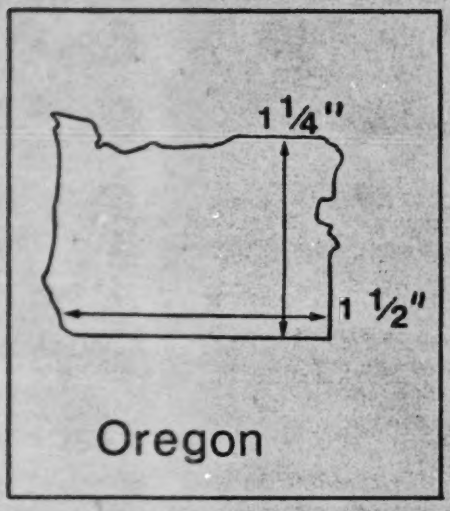
3. *Nearly 600 miles. The United States has vastly more miles of track.*

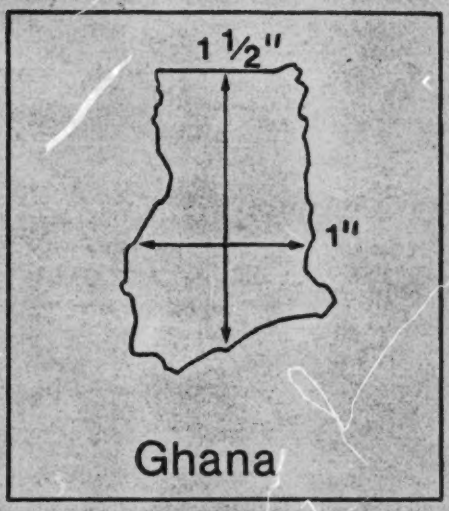
If the class's interest takes this turn, discuss whether the railroads are "finished" as a major means of transportation. Have students think about jammed highways and crowded airways. Should a new age of railroad building get underway? Can railroads send more goods and people on their way with less energy than trucks and busses can?

Introduce a comparison between Ghana and the Washington, D.C. metropolitan area. The comparison should emphasize the two capital cities, rather than geographic size. Ghana is nearly 14 times the size of the Washington, D.C. area. Ghana has an area of 92,000 square miles; Washington metropolitan about 6,700. Students might like to find a state that has a land area comparable to Ghana's. An atlas or a World Almanac are useful reference books. Ghana and the state of Oregon are close.

String Measuring Instruments

Show students how to use a piece of string as a measuring instrument. Use an overhead projector to show them how. Lay a piece of string over a boundary line on a world map. The length of string can then be measured against the scale line on the map. Divide the class into groups of four students each and give each group two pieces of string about 10 inches long (25 cm.). Have students locate and find states in the U.S. that comprise nearly the same area as Ghana. See below. Have students use their string measure in completing the exercises in Part 2.



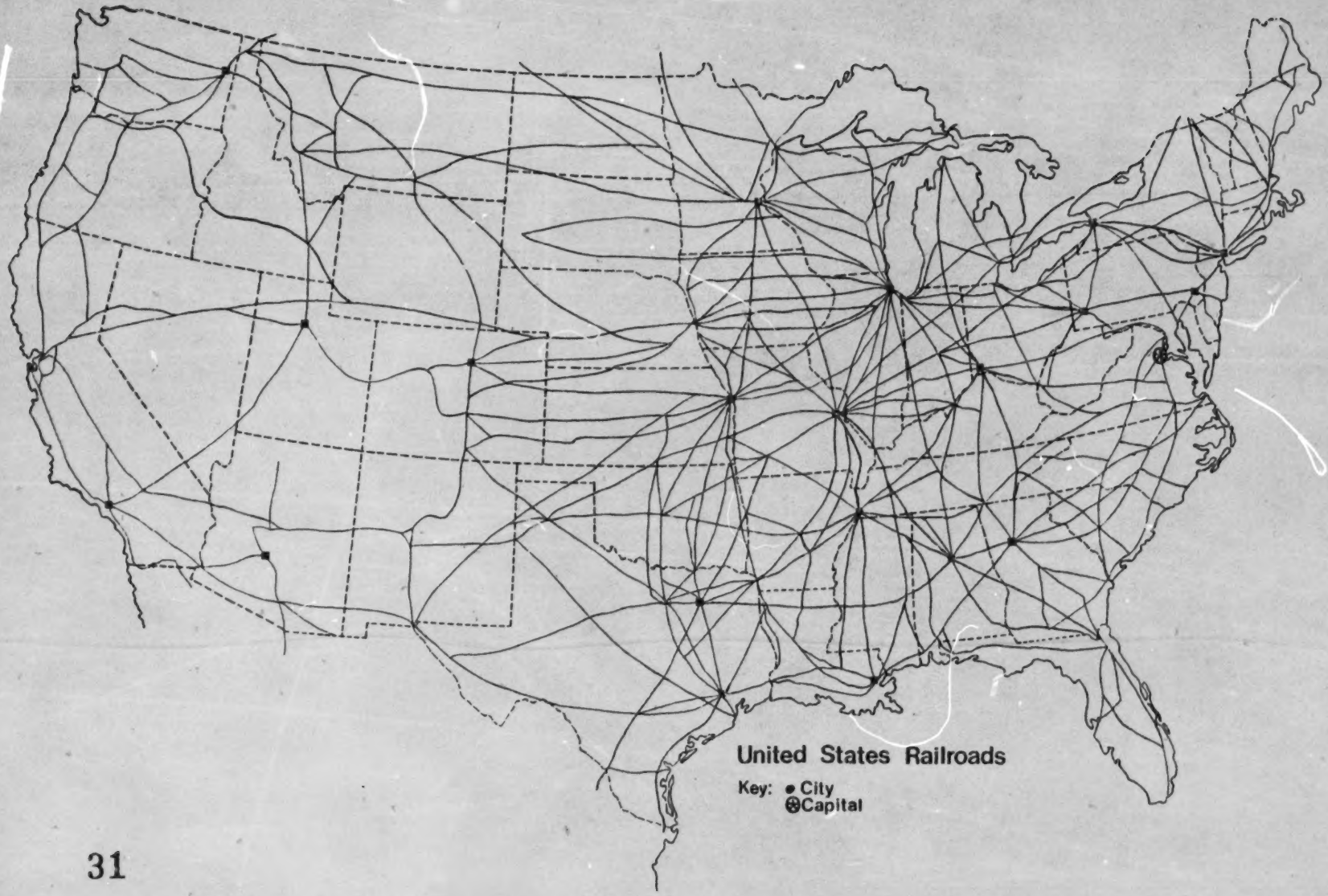


NOTE: Students should be informed that the conversion from inches to miles needs to be made before multiplying length times width. Otherwise the conversion factor needed is 1 sq. in. = $(250)^2$ or 62,500 square miles.

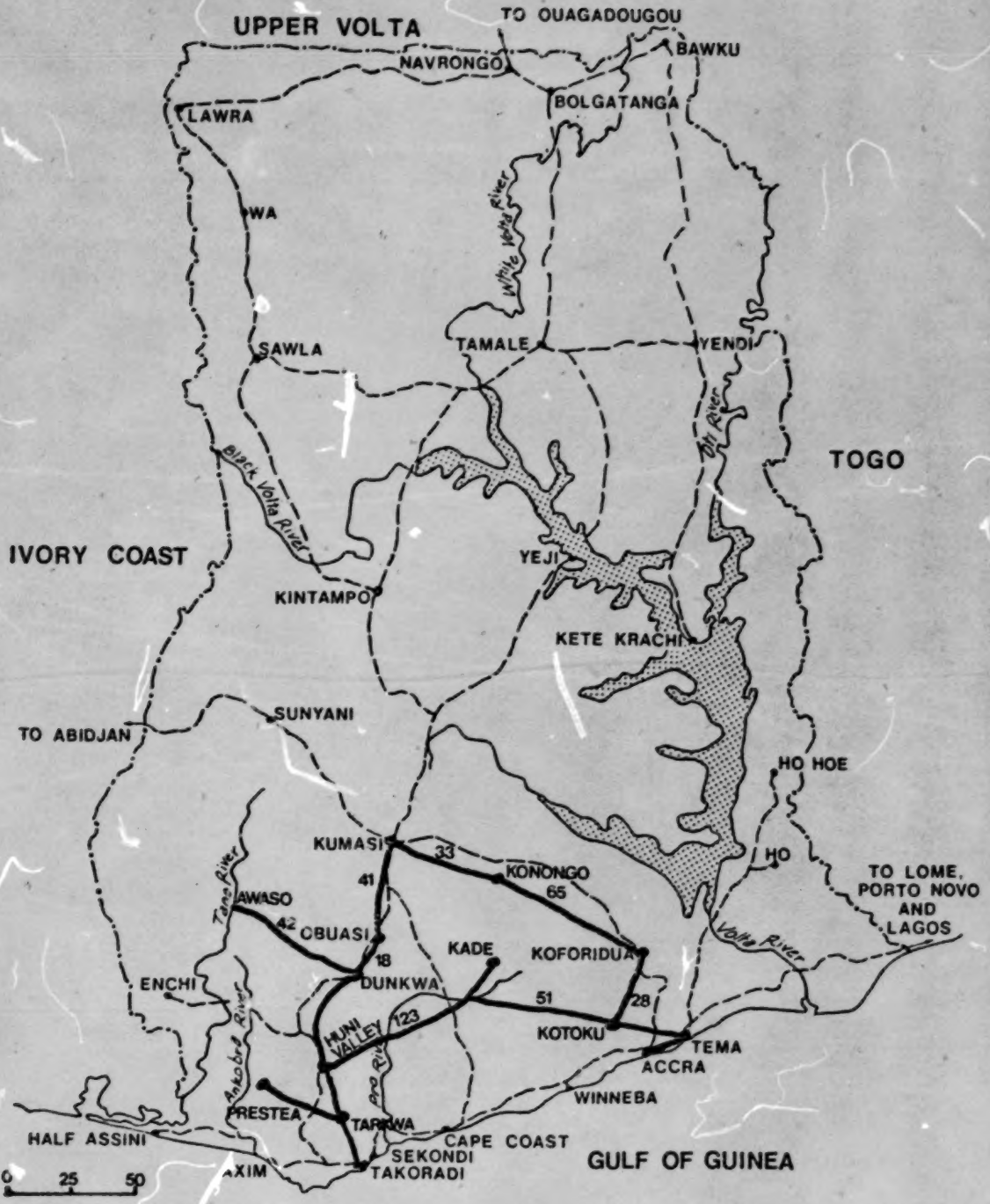
Concluding the Lesson

Assign a small group of interested students to draw a map of the entire U.S. on a different scale so that the apparent areas of the U.S. and Ghana on the maps are about the same size.

Have a group of students measure area by counting the number of standard units of measurement for area (e.g. square inch) required to cover the area to be measured. To do this, in this instance, Ghana's map would be better on a scale of 2" = 250 miles, so that six 1-inch squares would cover it. Put the finished maps on the bulletin board.


United States Railroads
Key: • City
⊗Capital

Railroads in Ghana



1. Can you send cocoa from Kumasi to Accra by train? What would be the most direct route?
2. How far by train is it from Sekondi to Accra? What is the route?
3. Use your string measure to find the total number of miles of railroad track in Ghana. How many miles do you estimate? How does the total number compare to the United States?

Part 2 Highways and Roads in Ghana

Distribute the map showing main roads in Ghana. You may wish to tell the students that Ghana has approximately 20,000 miles of roads in the nation. Of this number 2,400 miles have hard surfaces. The road network in the south is generally adequate for the people's needs. However, roads in the central and northern section are scarce. Most towns of any size can be reached by a good road, even in the more remote north.

Ask: What do people need roads for? How do people use roads in places where there are few cars? *(Elicit the response of busses, foot travel, bicycles.)* Have students take an imaginary trip on a bus travelling from Cape Coast to Navrongo. Trace the route north on the map that would get them there most directly. Which would be the most indirect and involve crossing the lake on a ferry boat?

NOTE: Ghanaians who want to reach their destination quickly travel on one of the large modern busses owned by the State Transport Corporation. This bus usually operates only between the main towns and makes few stops. The National Omnibus, however, stops at many villages and is used by those not in a hurry. Bicycles are widely used for individual transportation and for some trading of goods.

Distribute a highway map of the region in the United States where your students live. Have students compare the system with one part of Ghana. Where would your students expect to find the most gasoline and diesel fuel used--in Ghana or the U.S.?

Have students answer the questions on the Highway and Road map of Ghana. Answers to questions are:

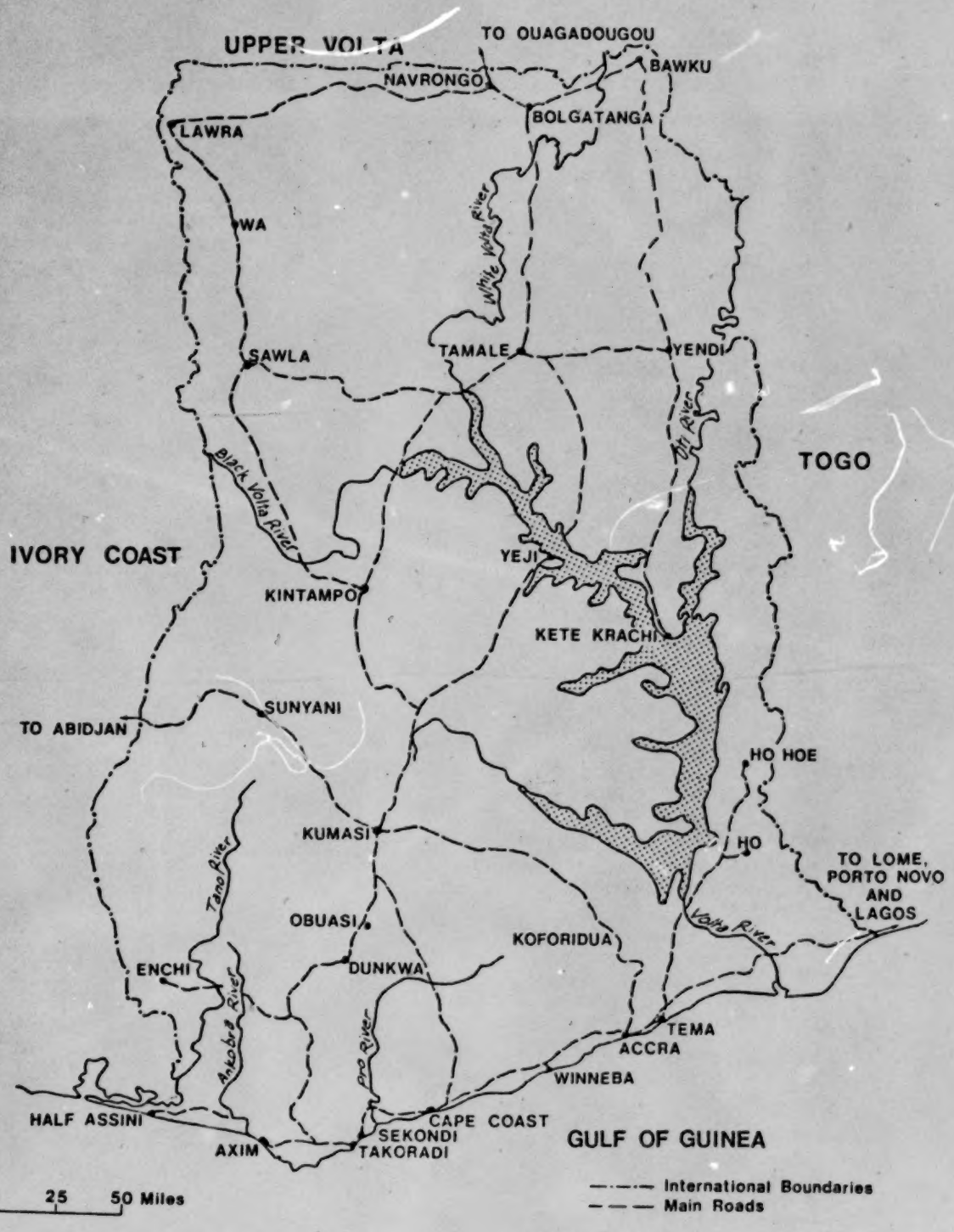
1. *Approximately 220 miles.*
2. *150 miles.*
3. *Walk; carry goods by hauling them on their heads or backs or by pulling.*

Highways and Roads in Washington, D.C.

People in Washington, D.C. depend greatly on a highway system. Most workers get to their jobs in privately owned cars on modern freeways. However, people are beginning to use the mass transit system more often. This system combines the subway and the bus system. Terminals can be found at the airport and at the railroad station.

Have students look at a road map of the Washington area, which is available at any gas station. Have them compare the highway system to Ghana's in terms of service and energy use. Discuss the energy that went into the building of the U.S. highways--from the gasoline in the car tanks to the oil-based asphalt paving.

Travel by Highways and Roads in Ghana



Questions

1. How far is it from Accra to Kintampo?
2 From Tema to Sekondi?
2. In case of a very heavy rain, how do you suppose people move their goods or get to work?

Part 3 Air Travel in Ghana

Distribute the map showing international air routes from Ghana to airports in Europe and the Middle East. Students may have some trouble reading a map with this perspective. Help them to locate Accra. Tell students that Ghana provides air service to three other cities which are not shown on the map. Have students use the previous maps and write in these three cities: Kumasi, Takoradi, and Tamale.

Air Travel in Washington, D.C. (or in your region)

Show students an airline map servicing your region. Point out the frequency of service on a domestic air schedule and the type of aircraft used. Both these make interesting comparisons to domestic flights out of Washington, D.C. and out of Ghana.

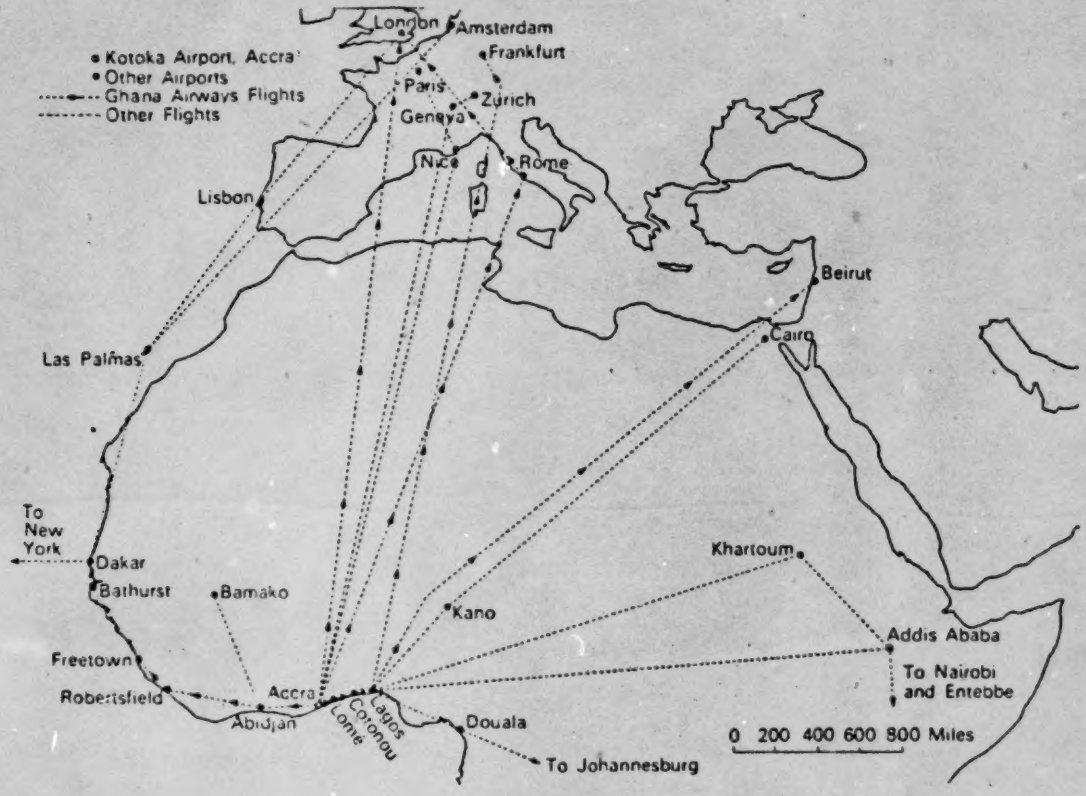
How do two cities compare in energy used to transport people and things by air? Which uses more energy to get things there faster--Ghana or Washington, D.C. (or your own city, if students would prefer to work with these data)?

Have students look at the map and scale and compute the following distances in air miles and answer the questions on the map.

1. From Accra to London, England. *(3200 miles.)*
2. From Accra to Rome, Italy. *(2600 miles.)*
3. From Accra to Addis Ababa, Ethiopia. *(2600 miles.)*
4. *You could go directly from Accra to London. Then leave London for Lisbon. A more roundabout way would take one from Accra to Dakar to Las Palmas to Lisbon.*
5. *Accra to Dakar. Dakar to New York.*

Travel by Airplane in Ghana

The fastest method of travel in Ghana is by air. Only a small number of people go by air, however. One reason is that there are only four cities that provide airports. These are Accra, Kumasi, Takoradi, and Tamale. Can you think of a reason why there are so few airports and air flights leaving Ghana?



Questions

1. How many miles is it from Accra to London, England?
2. How far from Accra to Rome, Italy?
3. How far from Accra to Addis Ababa, Ethiopia?
4. Describe two routes you could take to get from Accra to Lisbon.
5. How would you get from Accra to New York?

Part 4 Seaports in Ghana

There are two modern seaports in Ghana--Tema and Takoradi. Both are artificially constructed. The country has no natural harbors. Before these two ports were constructed all cargo had to be loaded onto surf boats and canoes and taken to ships anchored offshore in the open Gulf of Guinea. Surf boats were used mainly at Accra, Winneba, Cape Coast, and Sekondi. Water transport is the cheapest way of sending goods.

Find the two modern seaports in Ghana. What do you think is sent on boats to other countries? (Hint: Look back at the Factsheet on Map 1 in Lesson 2. Cocoa is the leading export.)

Seaports in Washington, D.C.

Point to the city of Washington on a wall map or have your students use their desk atlases. The Potomac River is used for pleasure crafts and for barge travel. Oil travels by tankers and barges to the city of Washington on the Chesapeake Bay and up the Potomac. However, Washington does not have a deep seaport.

Have your students compare their region's waterways with those of Ghana's. Use texts and easily available maps. Invite a boat captain to come to the class to talk about the uses of waterways in your particular region.

Concluding Parts 1, 2, 3 and 4

Use the following table to help you make some true statements about how energy is used in Ghana and in Washington, D.C.

Bicycles	
Walking	1.7 times the energy required for bicycling.
Busses	6.0 times the energy required for bicycling.
Railroads	9.5 times the energy required for bicycling.
Cars	24 times the energy required for bicycling.
Airplanes	54 times the energy required for bicycling.

Questions to help you get started:

1. Which place uses the most energy?
2. Which has people doing more things?
3. Does doing things require energy?
4. Does going faster, higher, more often, and by more people mean using more energy?
5. What does the table tell you about energy and the way people live in the United States? In Ghana?

Lesson 4: HOW IS ELECTRICITY USED IN WASHINGTON, D.C AND IN GHANA? BY WHOM? WHERE DOES MOST O IT COME FROM?

Overview In this lesson the student will study the electrical energy consumption in two parts of the world. Emphasis will be placed on population and per capita energy consumption.

Objectives The student should be able to:

1. Compare electrical use in Washington, D.C. and in Ghana by using a bar graph.
2. Predict trends from prepared information.
3. Interpret a table.

Time Allotment Four class periods.

Background Information (Teacher Use Only) Electricity in the Washington, D.C. area has been a basic need for the total population for many years. Electricity in Ghana was used as early as 1914, but its people were not significantly dependent on it until after the Akosombo Dam was completed in 1965.

The use of electrical energy is on the rise in Ghana. As of 1976, only approximately 35% of its total population had electrical service, but the demand for electricity is constantly increasing. To meet these demands, another dam will be built. As more electrical energy becomes available to the people of Ghana and they become more energy dependent, you will find that they too will demand and consume more and more.

Note: This lesson is composed of four sets of activities. Each set of activities is designed to help students understand the dependence of people in the Washington, D.C. area on electrical energy, and the emerging energy dependency in the country of Ghana.

In each activity there are questions and problems that involve large numbers. Many of them have been rounded off so that arithmetic operations for the students will, in most cases, be simplified.

(In some cases, it may be necessary to help students set up the problem and help them find the solution.)

Student Activity 1

Energy Use in Ghana

Directions: Look carefully at the bar graph. Then answer each question below.

1. The vertical axis is the straight up and down line. What does it show?
   (Millions of KWH of energy consumed in Ghana between 1965 and 1972.)

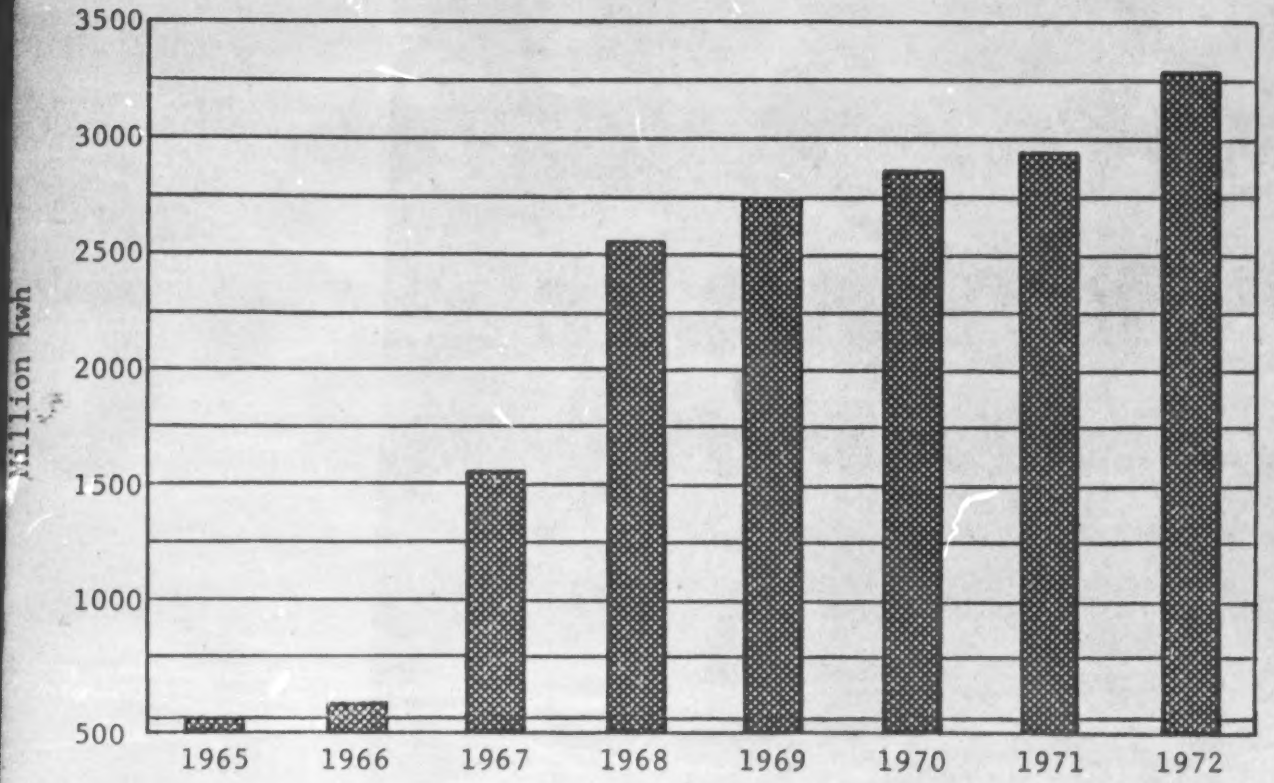
2. The horizontal axis runs across from left to right. How many years are shown?
   (Eight years.)

3. What year shows the most energy being used?
   (1972.)

4. What trend do you see developing about energy use in Ghana?
   (Energy use is increasing each year.)

5. Energy use in Ghana took a big jump upward between 1966 and 1967. What do you think caused such a big jump?
   (The completion of the Akosombo Dam.)

Electrical Energy Consumption in Ghana
1965-1972



Student Activity 2

Energy Use in Washington, D.C.

Directions: Look carefully at the bar graph. Answer each question.

1. What does the vertical axis show?
   (Millions of KWH of energy consumed in Washington, D.C. between 1965 and 1972.)

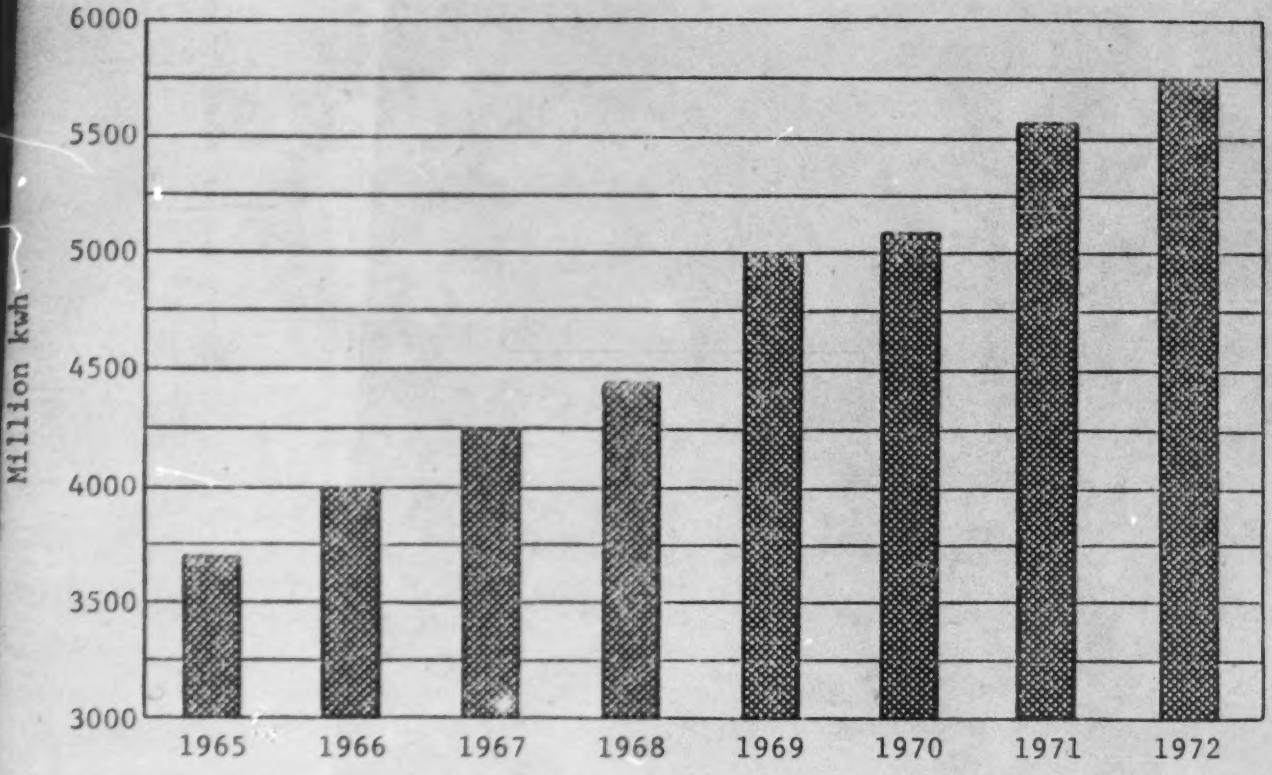
2. How many years are shown on the horizontal axis?
   (Eight years.)

3. What year shows the largest amount of energy being used?
   (1972.)

4. What trends do you see?
   (Energy use is increasing each year.)

5. Compare the energy use in Washington with Ghana. What true statement could you make?
   (Answers will vary. Two possibilities follow. There has been a steady increase in the use of electricity over the past eight years. OR Washington, D.C. uses more electricity than all of Ghana.)

Electrical Energy Consumption in Washington, D.C.
1965-1972



Student Activity 3

Comparing Electricity Use in the Nation of Ghana and One City in the United States: Washington, D.C.

Look carefully at the two bar graphs again. Remember that when we use electricity, we call it using kilowatt hours (KWH). Answer these questions:

1. Which place was using more electricity in 1965?
   (Washington, D.C.)

2. Look carefully at the numbers for kilowatt hours in 1965 on both graphs. Which place--Washington, D.C. or Ghana--used more than seven times as much electricity?
   (Washington, D.C.)

3. Which place started off the six years with much higher electrical use--Ghana or the city of Washington?
   (Washington, D.C.)

4. Is electricity use growing in <u>both</u> places? Why or why not?
   (Yes. Graphs show nearly steady growth in electrical use.)

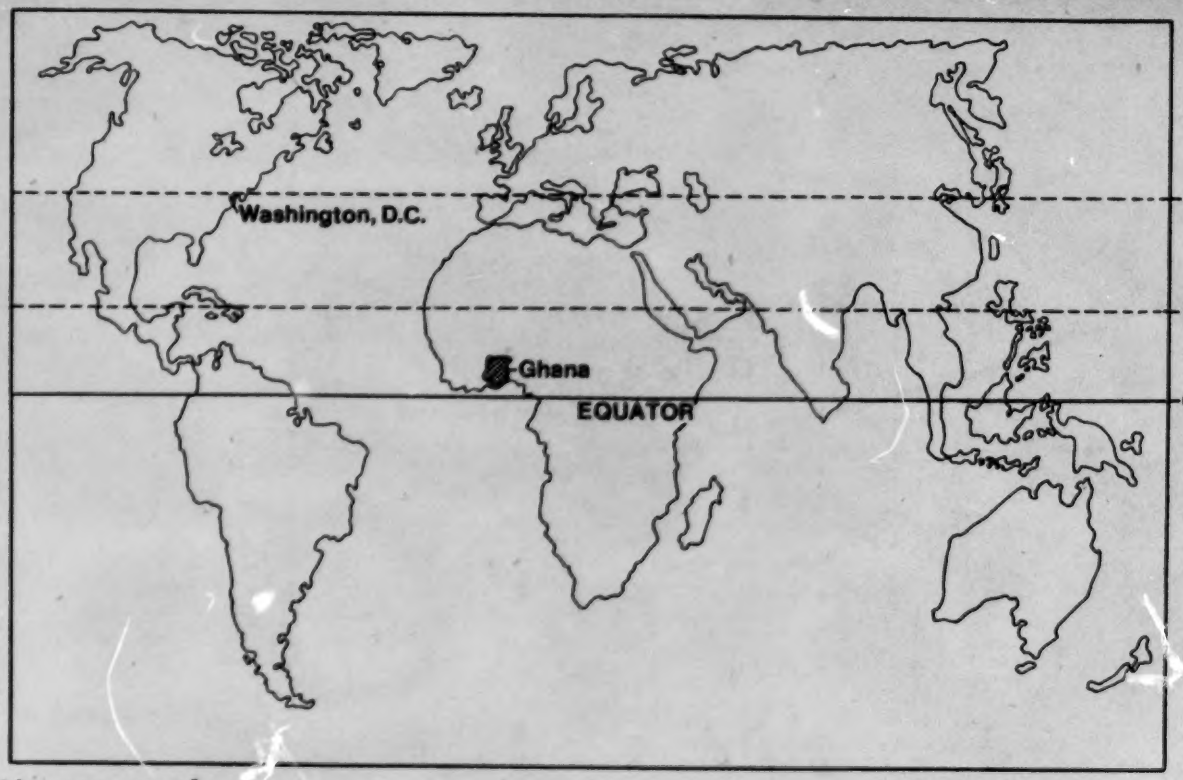
5. Why do you suppose you could not <u>easily</u> graph the kilowatt hours for the entire United States and compare this with Ghana? What do you think the graph would look like?
   (Unless you changed the scale, the graph for the United States would be huge compared to the nation of Ghana, which has only recently begun developing more uses for electricity.)

6. Which place probably has more lights, air-conditioning, appliances? How can comparing the two graphs help you decide?
   (Washington, D.C.)

7. Which place probably burns more fossil fuels to make electricity?
   (Washington, D.C.)

Student Guide

Map 1



Latitude and Climate

Low Latitudes 0° to 30°
Tropical climate -- hot all year round.
Tropical savanna -- a dry season and wet season.

Middle Latitudes 30° to 60°
Humid subtropical -- summers warm and humid, winters mild (seasonal changes and very changeable weather).

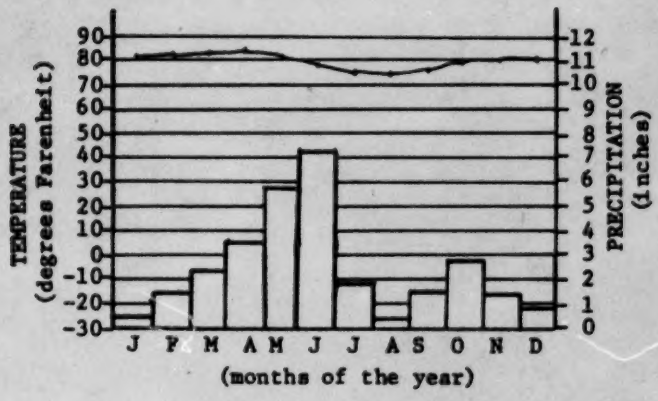
High Latitudes 60° to 90°
Tundra -- winters are very cold (in the extreme north and south it is cold all year round).

Student Activity 1

Climagraph for Accra, Ghana and Washington, D.C.

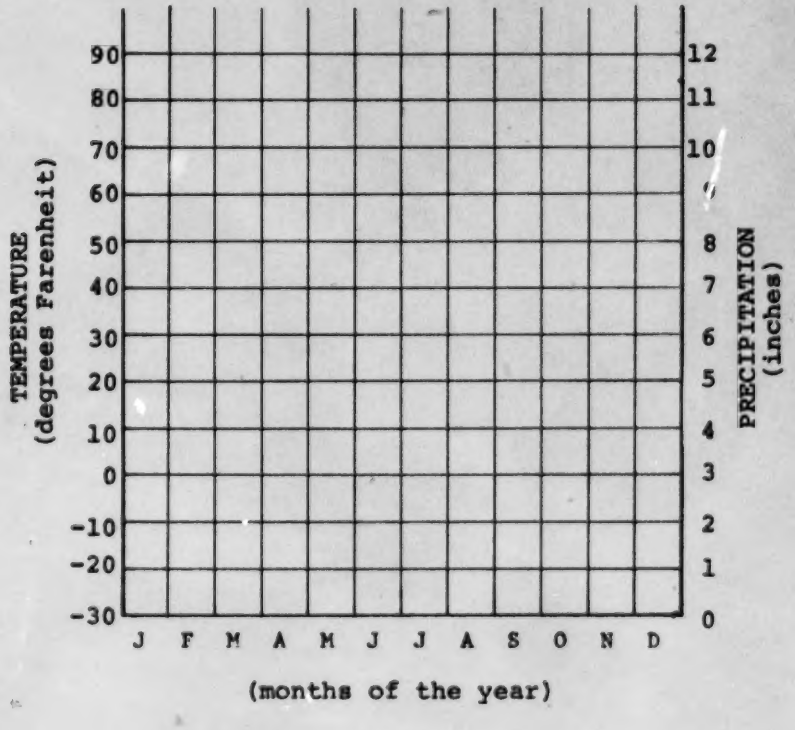
A sample climagraph for Accra, Ghana (Africa)
_____ ° South Latitude____ ° East Longitutude

Chart 2



Climagraph for Washington, D.C.
_____ ° North Latitude____ ° West Longitude

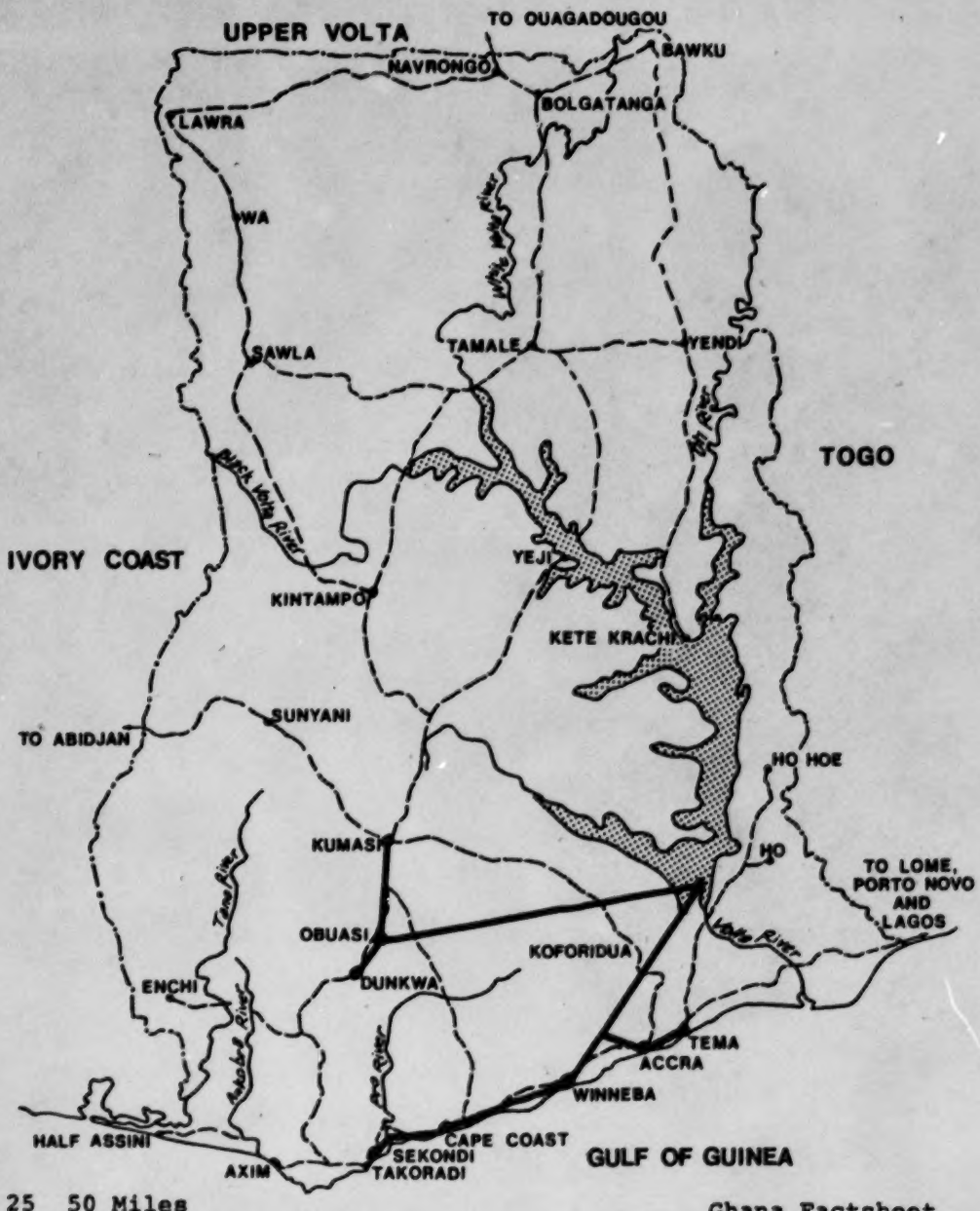
Months	Temperature (°F)	Precipitation (inches)
January	33	2.3
February	38	2.7
March	42	3.0
April	50	3.0
May	55	3.0
June	62	3.2
July	71	3.7
August	77	4.0
September	68	3.5
October	53	3.0
November	42	2.5
December	35	2.0



Map 1

Lesson 2

Electrical Power Sources in Ghana



Ghana Factsheet

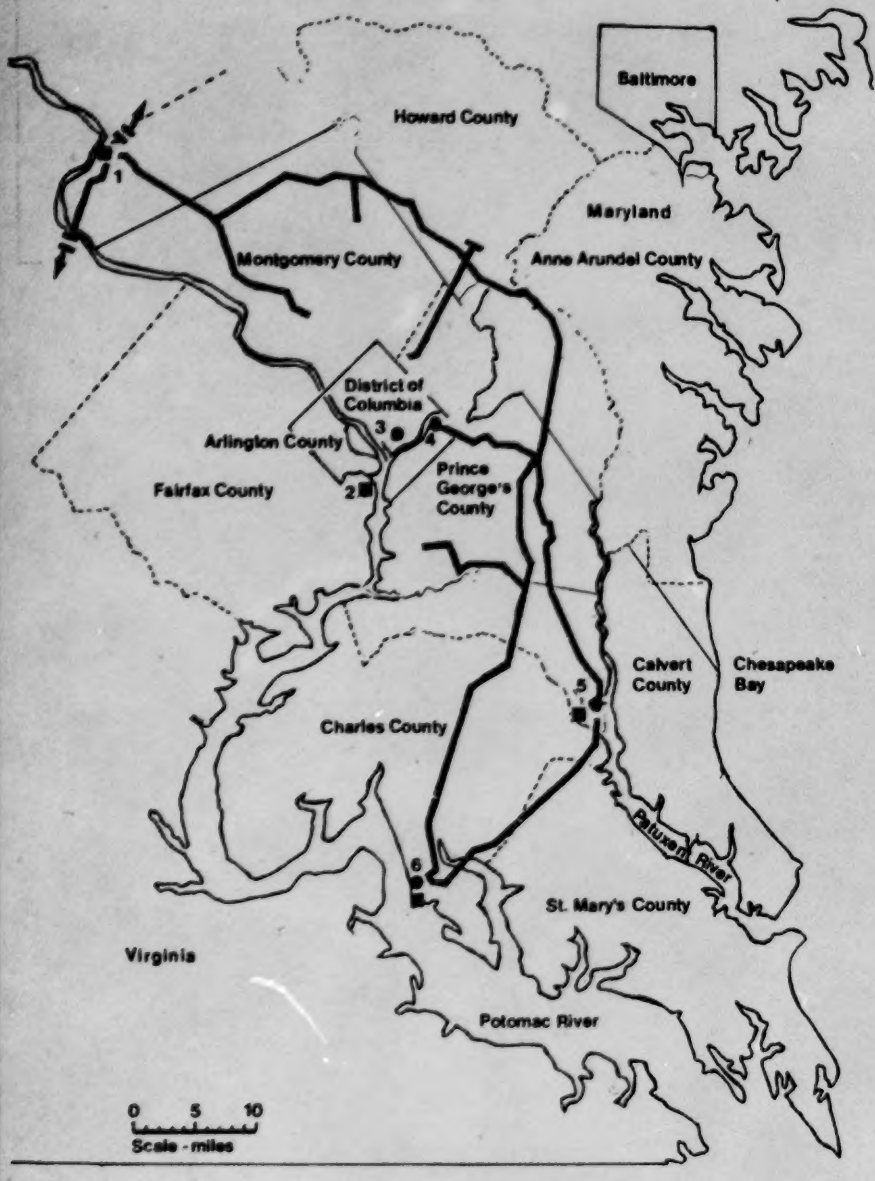
Capital City	Accra
Population of Accra	633,880
Chief Industry	Growing and exporting cocoa
Average Income per family per year	$560

Map 2

Electrical Power Sources in the Greater Washington, D.C. Area

PEPCO Service Area

Transmission Line (230 kv)



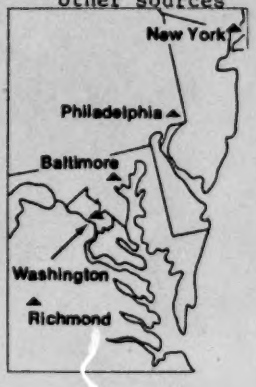
PEPCO Generating Plants by Type

■ Coal Fueled

● Oil Fueled

	Net Capacility at December 31, 1976
1. Dickerson	548 MW
2. Potomac River	458 MW
3. Buzzard Point	222 MW
4. Benning	684 MW
5. Chalk Point	1262 MW
6. Morgantown	1112 MW

Power from other sources



U.S.A.

Washington, D.C. Factsheet

Capital City	Washington, D.C.
Population of Washington, D.C.	757,000
Chief Industry	Government, shops, many services
Average Income per family each year	$19,000

Student Activity 3

Case Study

What would happen if the lights went out? Lisa, a seventh grader living in the Washington, D.C. area and Caroline, a seventh grader living in Accra, Ghana, are on a Washington, D.C. playground discussing their countries. The time is the summer of 1977. (Note: Caroline speaks a more formal English because she has been going to schools that have a British influence. The children in Ghana do not use as much slang as we do. [Most Ghanaians have first names just like those we have.])

Caroline: When I came to the United States this summer something strange happened. I was staying with my Aunt in New York City and it had been hot all day. That night there was a terrible storm. I awoke and it was dark everywhere. My Aunt told me there was no electricity in all of New York City. The air conditioning was off and the apartment was very hot. It was like that for 25 hours. People did not go to work and some people got angry. Does this happen often?

Lisa: No. That was unusual. I think it was an accident.

Caroline: Did it ever happen in Washington?

Lisa: No, I don't think so. PEPCO says it never happened here - yet.

Caroline: What is PEPCO?

Lisa: PEPCO is the Potomac Electric Power Company. They make the electricity here.

Caroline: Oh, that's like our Electric Corporation in Accra the capital city. Accra is my hometown and it's the capital of Ghana. Why wouldn't the power fail here?

Lisa: I guess because we get power from six power plants/generating stations around the Washington area, and if one isn't working the others could still work.

Caroline: Suppose they all went out?

Lisa: Well, we belong to a network of energy producers called the Pennsylvania, New Jersey, Maryland Interconnection. When it's very hot or very cold and we need more power than we make here, we can get power from this interconnection. In an emergency that's where the power would come from.

Caroline: But if it would?

Lisa: Well, in the summer the air conditioning wouldn't work. That would be awful! If you stay here all summer you'll find Washington really gets hot. Food might spoil because the refrigerator would be off too! And the subway wouldn't work, so people would have a hard time getting to work. And there wouldn't be any traffic lights so traffic would get tangled up. There

wouldn't even be T.V., and I'd sure miss that. But it would be worse at night. Without street lights you couldn't even be outside at night. It would be one grand mess!

Caroline: Would you go to school?

Lisa: Yes, we'd go to school -- no matter what!

Caroline: Sounds pretty bad. You really depend on electricity.

Lisa: Why, we couldn't even cook because a lot of homes use electric appliances. And what would really be bad is we couldn't even go to the shopping centers or to the movies! That's scary!

Caroline: In my country, I don't think we need electricity as much as you do.

Lisa: You mean that if the electricity went off, you would do the same things you normally do?

Caroline: I think so. Our temperature stays pretty much the same, so we don't need electricity to heat our homes. It does not get below 60°.

Lisa: But it's hot in Ghana. How do you keep cool?

Caroline: I'm used to it and it doesn't bother me. We don't use air conditioners. We fan ourselves sometimes.

Lisa: How do you cook food, and keep your food cold?

Caroline: My mother uses the charcoal pot and cooks outside. Grandma does, too. Most people in Ghana cook this way. It's like a patio cookout - only Ghanaians cook this way most of the time. We have a refrigerator, but most homes

don't have them. We buy fresh meats and vegetables every day from the market.

Lisa: What about reading and T.V.?

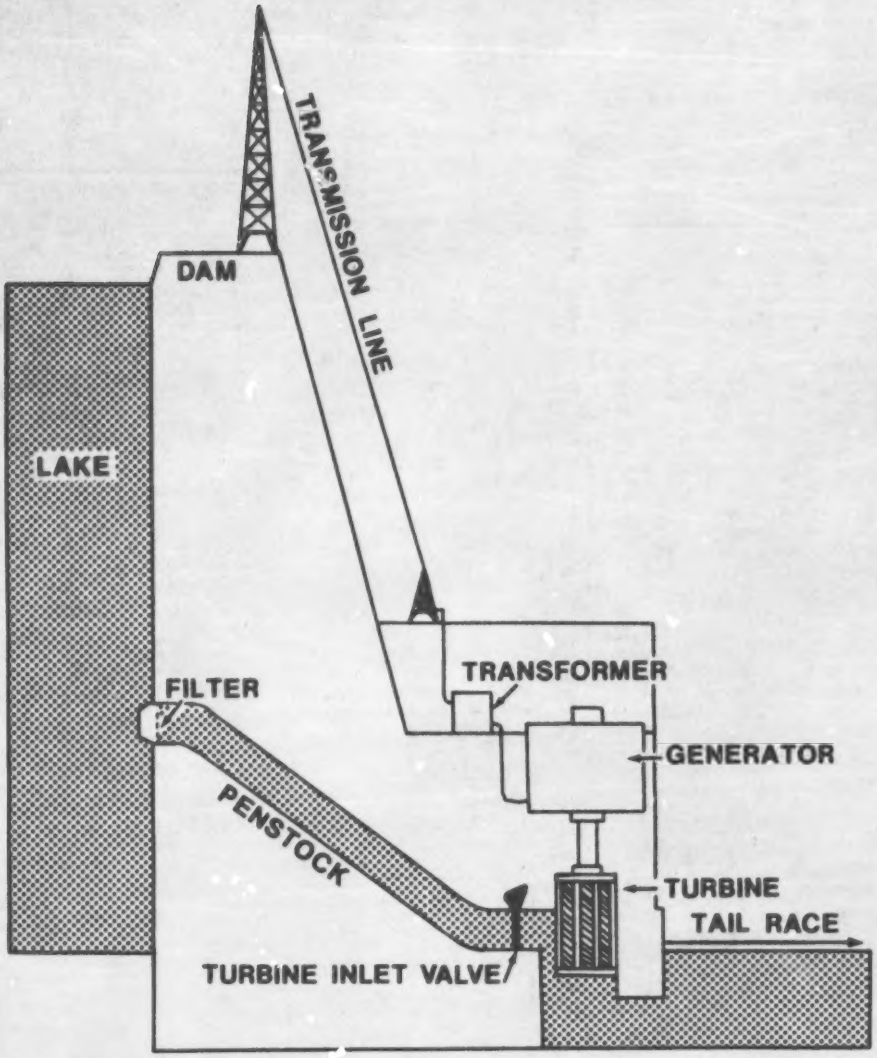
Caroline: Well, at night if the lights were out, I would use a candle or an oil lamp. Most Ghanaians don't have a T.V. set so we wouldn't miss it.

Lisa: So a power blackout wouldn't bother you?

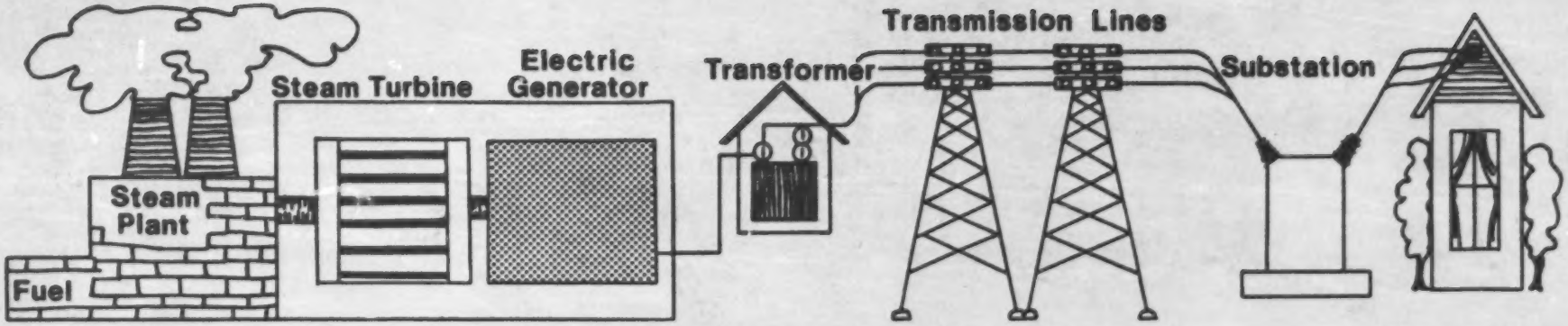
Caroline: Oh, yes! But it wouldn't be as bad as it is here. People could still go to work because we would use electricity from diesel power plants.

Lisa: Could you get power from other countries, like the Ivory Coast or Togo?

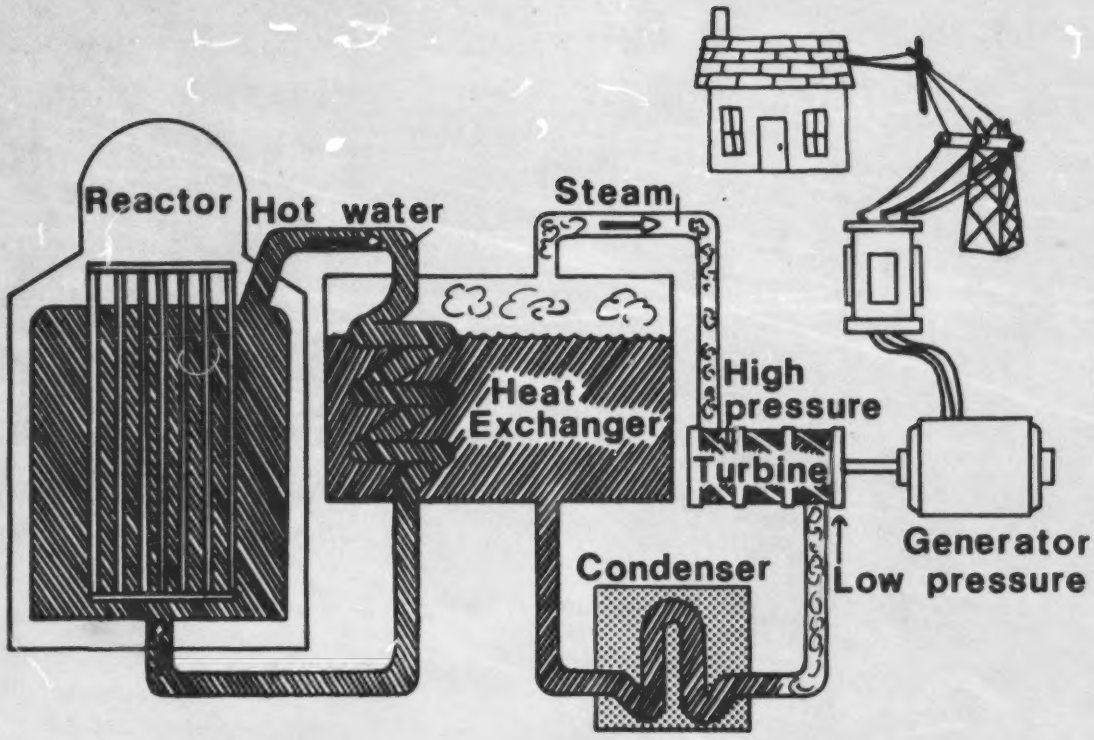
Caroline: No, we sell a lot of energy to Togo and we don't have an interconnection as you called it. All of our electricity comes from Akosombo Dam or diesel generating plants or from candles, oil lamps and charcoal stoves.



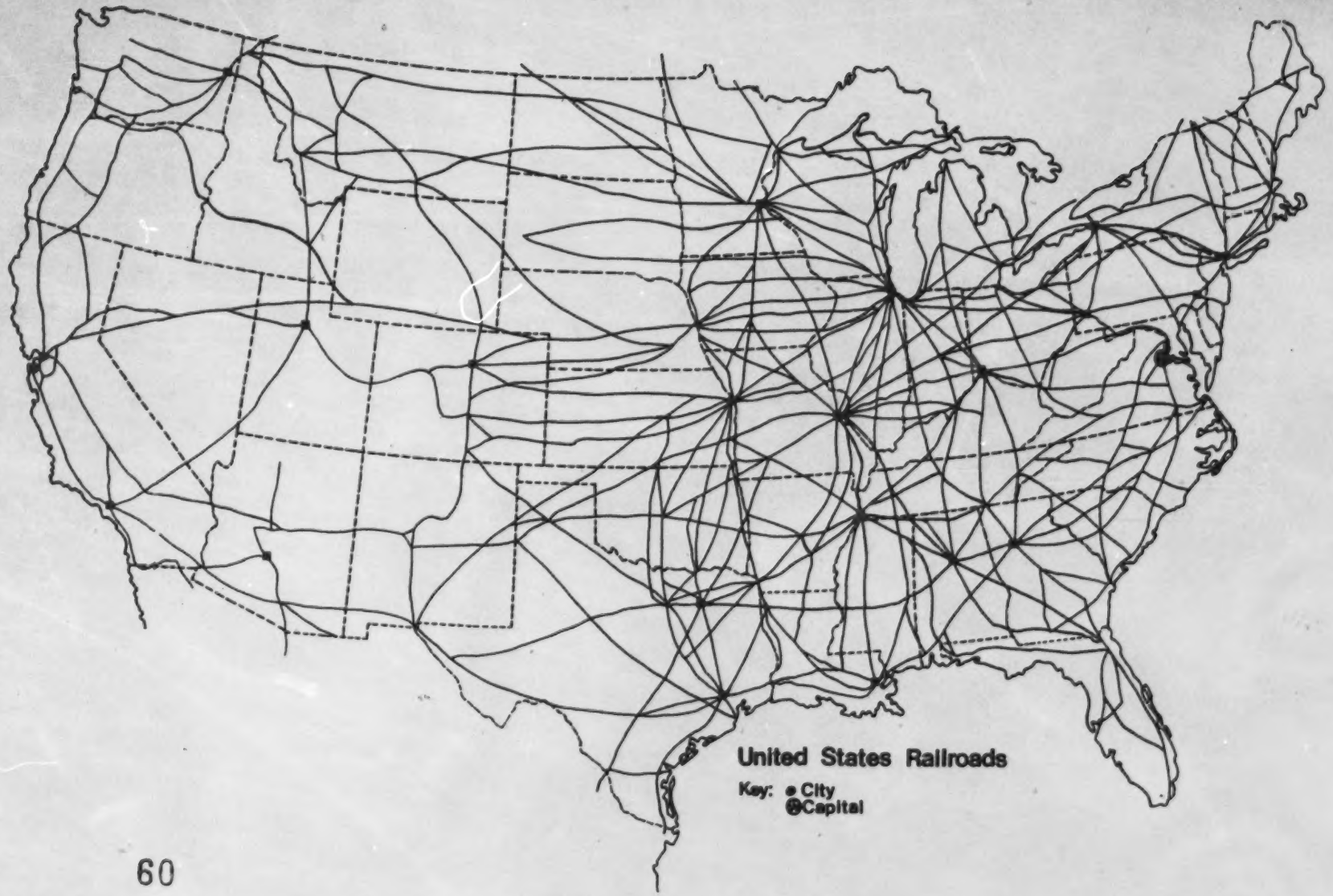
Akosombo Dam in Ghana



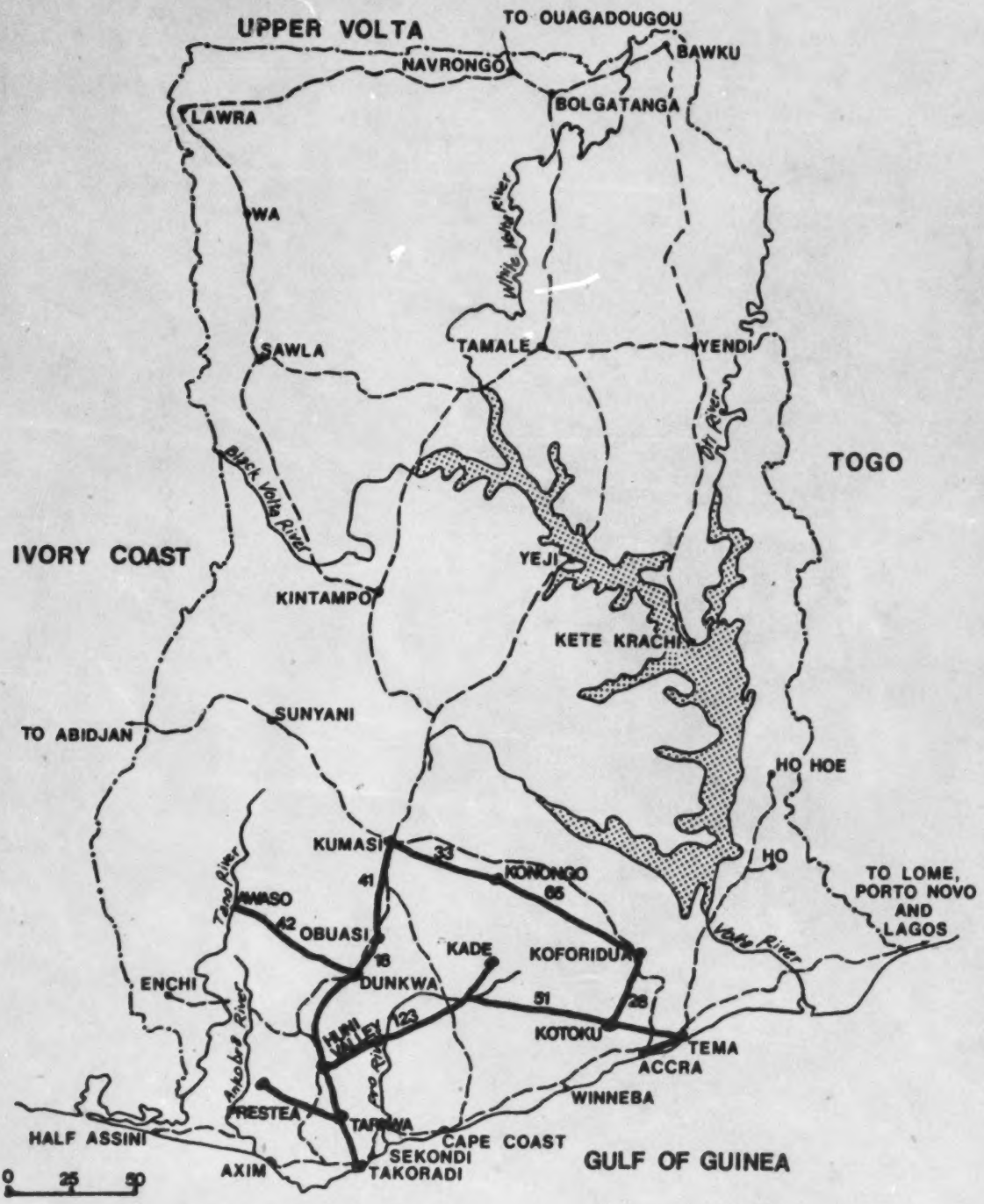
Power Station in Washington, D.C.



Nuclear Generating Station

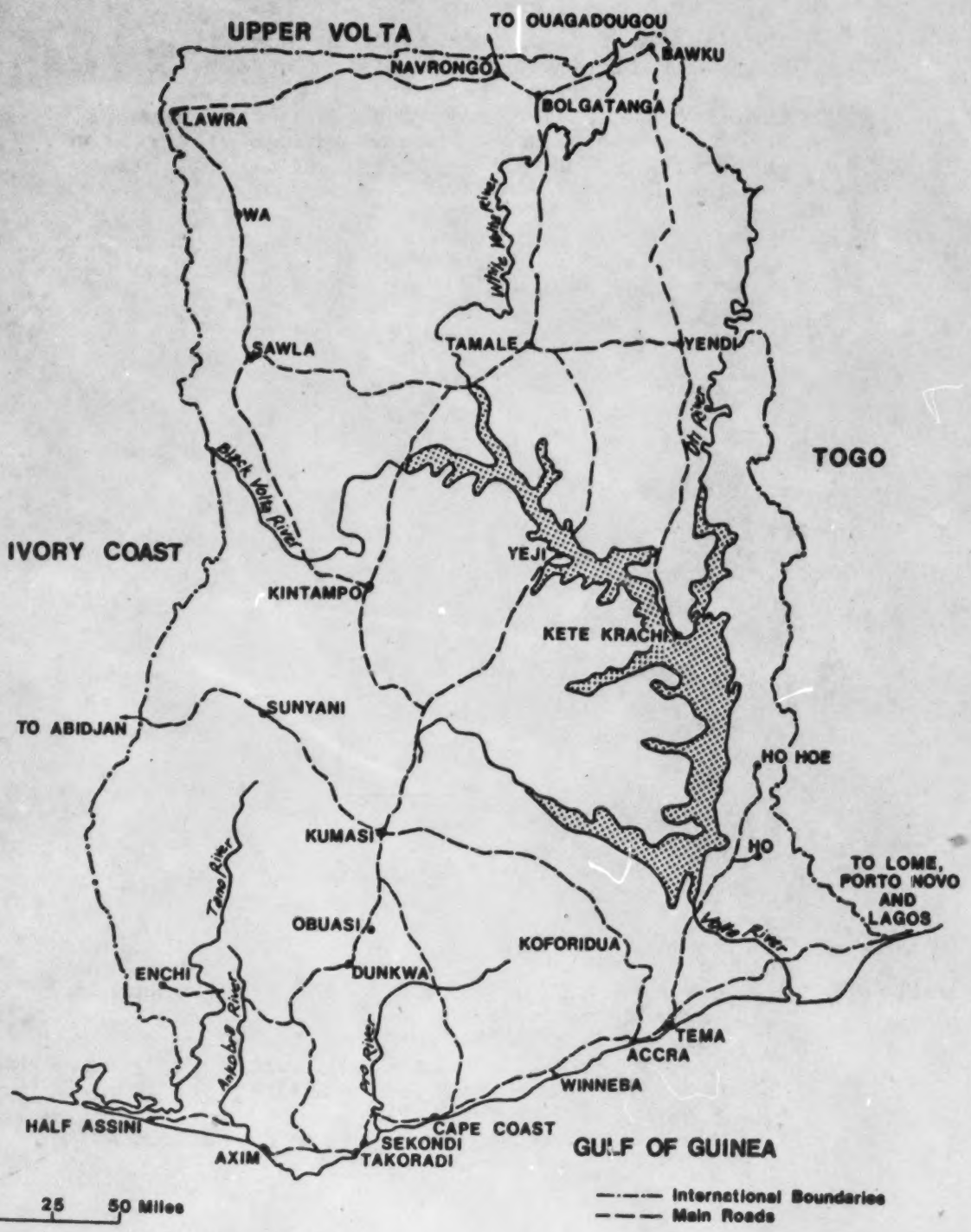

United States Railroads
Key: • City
⊛Capital

Railroads in Ghana



1. Can you send cocoa from Kumasi to Accra by train? What would be the most direct route?
2. How far by train is it from Sekondi to Accra? What is the route?
3. Use your string measure to find the total number of miles of railroad track in Ghana. How many miles do you estimate? How does the total number compare to the United States?

Travel by Highways and Roads in Ghana

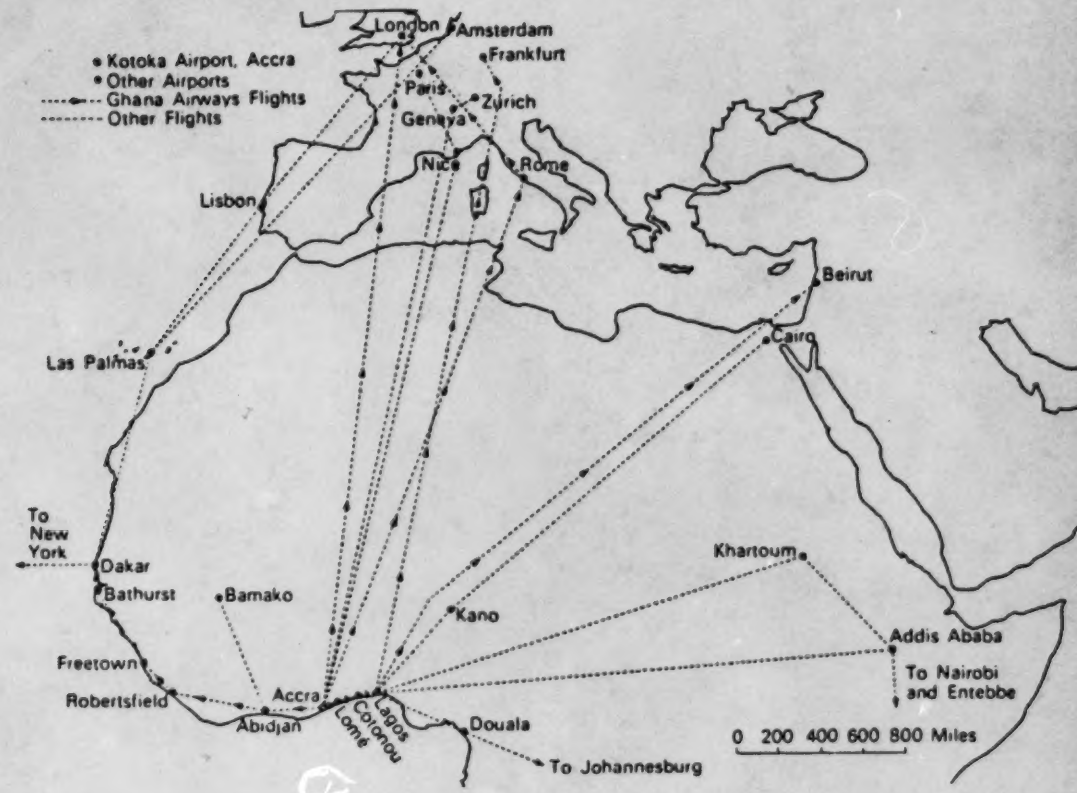


Questions

1. How far is it from Accra to Kintampo?
2 From Tema to Sekondi?
2. In case of a very heavy rain, how do you suppose people move their goods or get to work?

Travel by Airplane in Ghana

The fastest method of travel in Ghana is by air. Only a small number of people go by air, however. One reason is that there are only four cities that provide airports. These are Accra, Kumasi, Takoradi, and Tamale. Can you think of a reason why there are so few airports and air flights leaving Ghana?



Questions

1. How many miles is it from Accra to London, England?
2. How far from Accra to Rome, Italy?
3. How far from Accra to Addis Ababa, Ethiopia?
4. Describe two routes you could take to get from Accra to Lisbon.
5. How would you get from Accra to New York?

Student Activity 1

Energy Use in Ghana

Directions: Look carefully at the bar graph. Then answer each question below.

1. The vertical axis is the straight up and down line. What does it show?

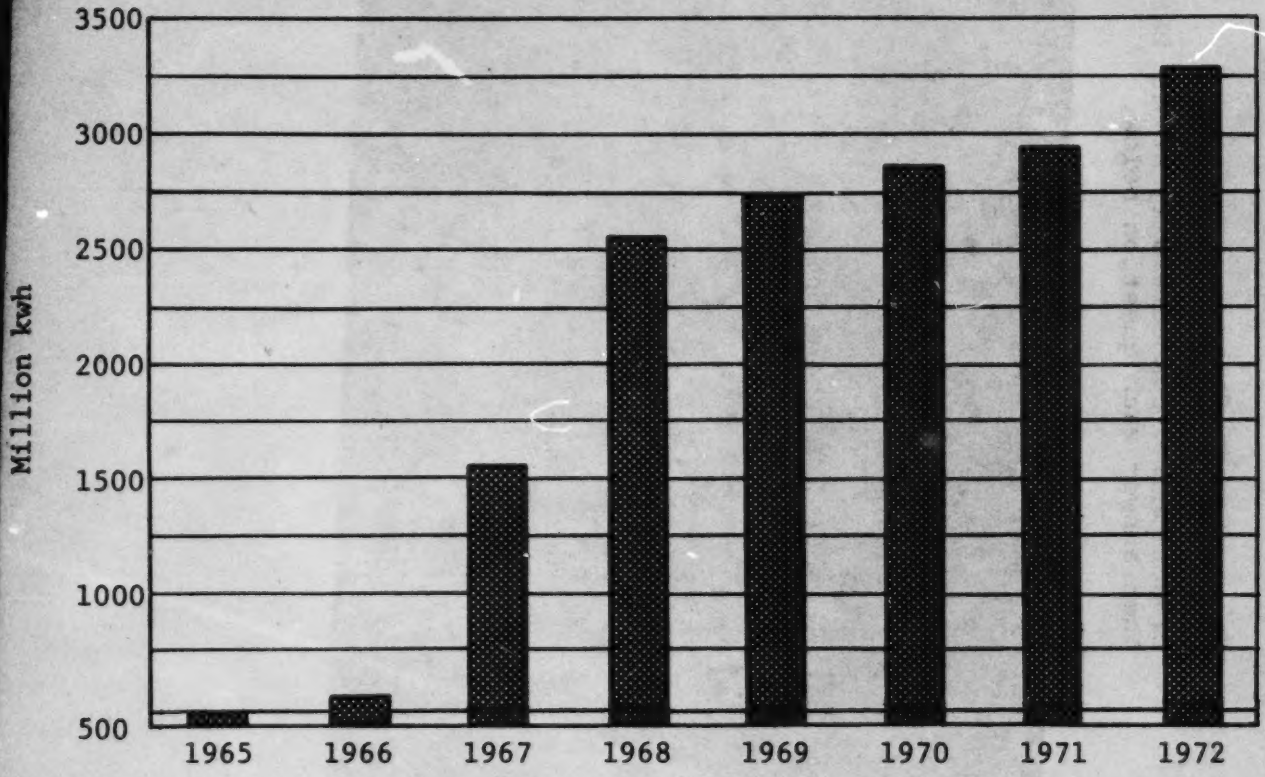
2. The horizontal axis runs across from left to right. How many years are shown?

3. What year shows the most energy being used?

4. What trend do you see developing about energy use in Ghana?

5. Energy use in Ghana took a big jump upward between 1966 and 1967. What do you think caused such a big jump?

Electrical Energy Consumption in Ghana
1965-1972



Student Activity 2

Energy Use in Washington, D.C.

Directions: Look carefully at the bar graph. Answer each question.

1. What does the vertical axis show?

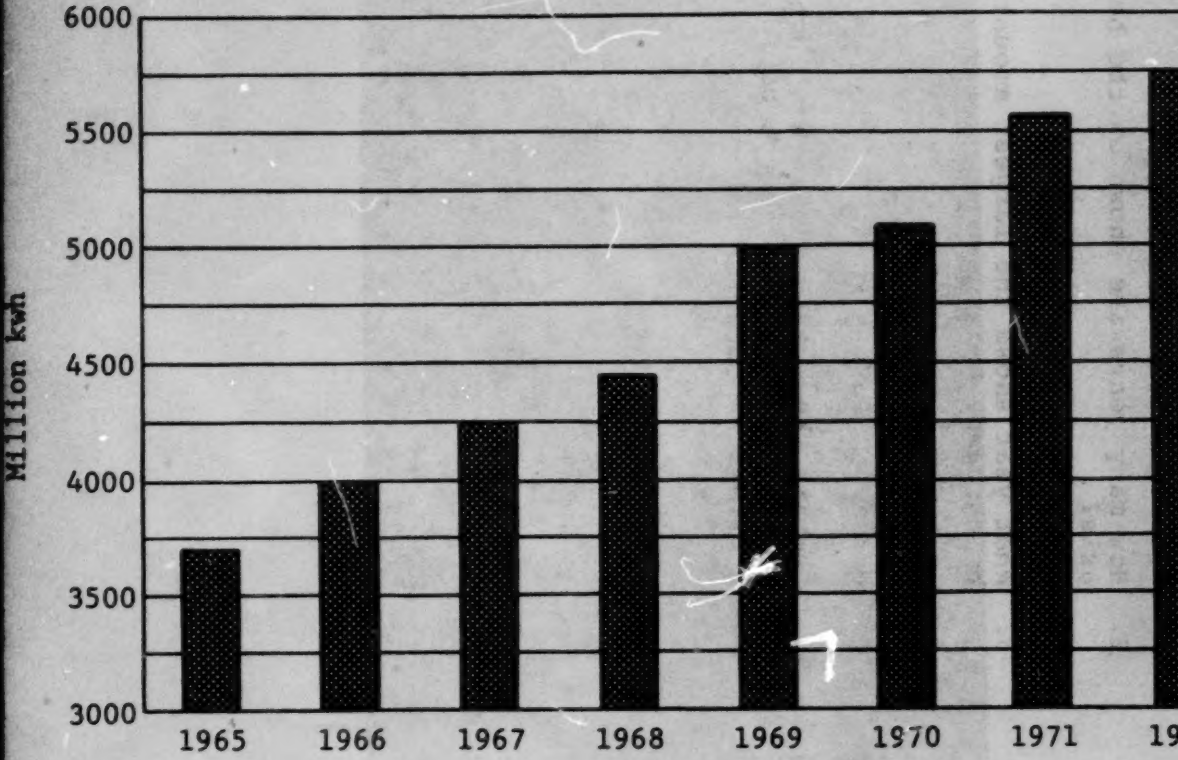
2. How many years are shown on the horizontal axis?

3. What year shows the largest amount of energy being used?

4. What trends do you see?

5. Compare the energy use in Washington with Ghana. What true statement could you make?

Electrical Energy Consumption in Washington, D.C.
1965-1972



Student Activity 3

Comparing Electricity Use in the Nation of Ghana and One City in the United States: Washington, D.C.

Look carefully at the two bar graphs again. Remember that when we use electricity, we call it using kilowatt hours (KWH). Answer these questions:

1. Which place was using more electricity in 1965?

2. Look carefully at the numbers for kilowatt hours in 1965 on both graphs. Which place--Washington, D.C. or Ghana--used more than seven times as much electricity?

3. Which place started off the six years with much higher electrical use -Ghana or the city of Washington?

4. Is electricity use growing in <u>both</u> places? Why or why not?

5. Why do you suppose you could not <u>easily</u> graph the kilowatt hours for the entire United States and compare this with Ghana? What do you think the graph would look like?

6. Which place probably has more lights, air-conditioning, appliances? How can comparing the two graphs help you decide?

7. Which place probably burns more fossil fuels to make electricity?